VOLUME XXXV, No. 184 • SECTION I • JANUARY-FEBRUARY, 1951

ORDNANCE

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Section I of two sections

Reg. U. S. Pat. Off.

K. T. KELLER
Director of Guided Missiles

IN THIS ISSUE...

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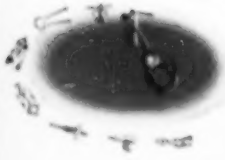

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The Magazine of Scientific and Industrial Preparedness

Vol. XXXV JANUARY-FEBRUARY, 1951 No. 184

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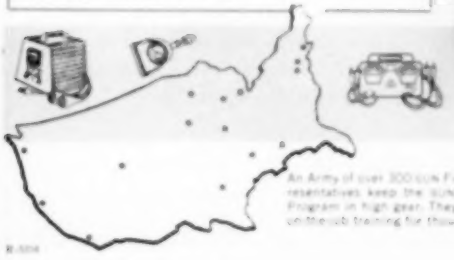

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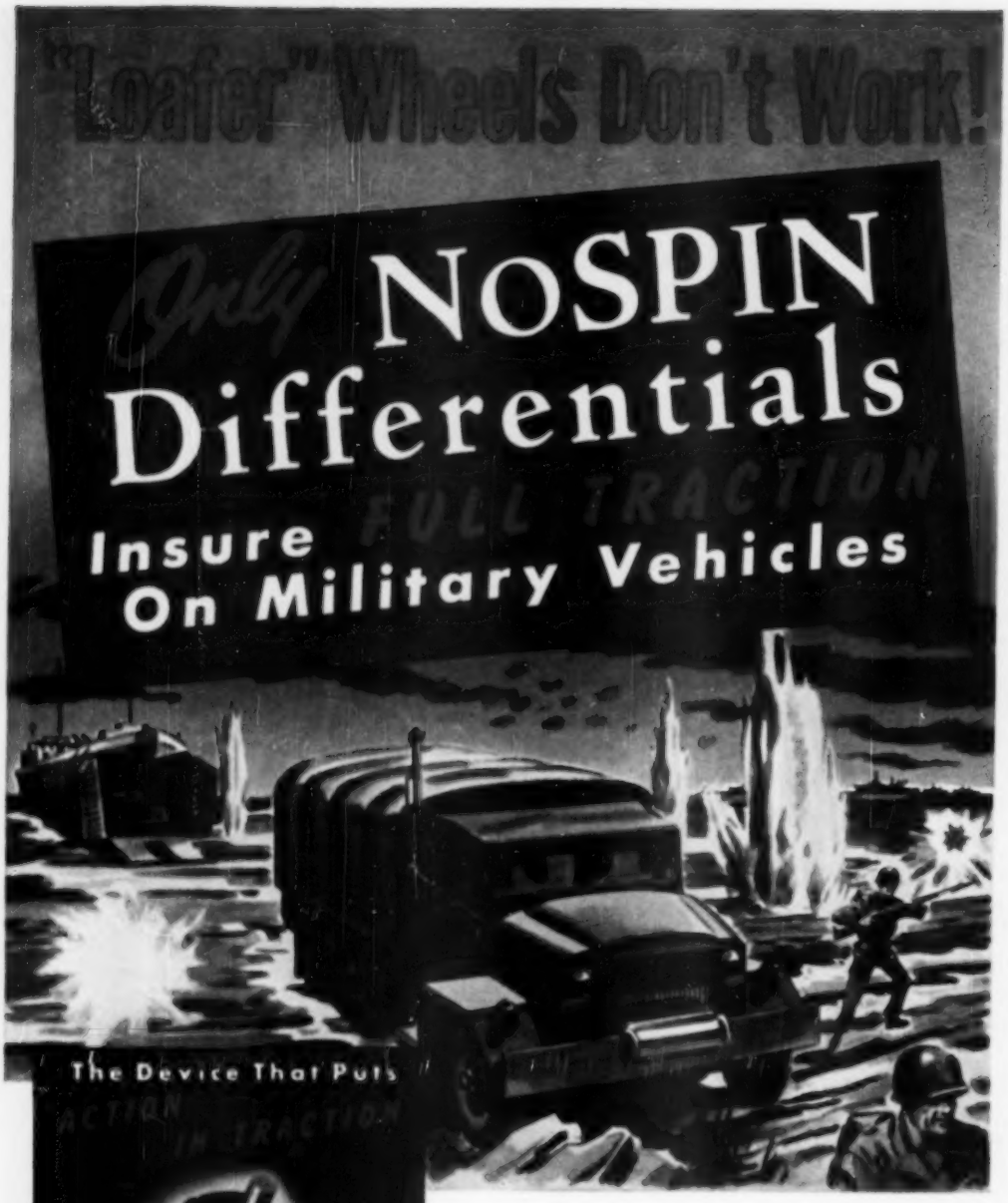

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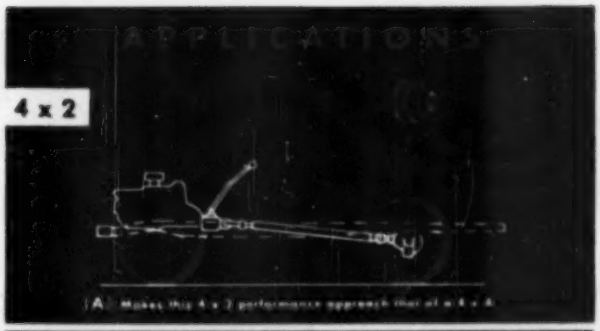

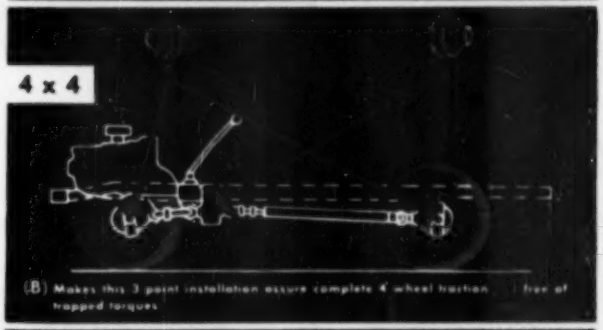

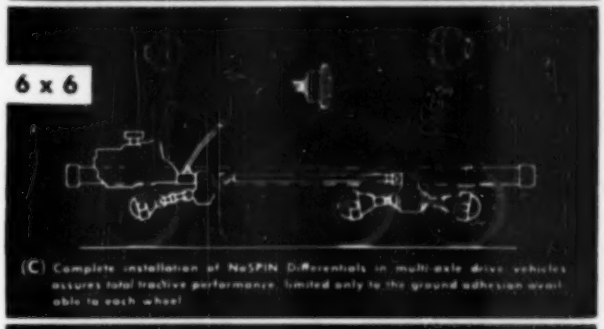
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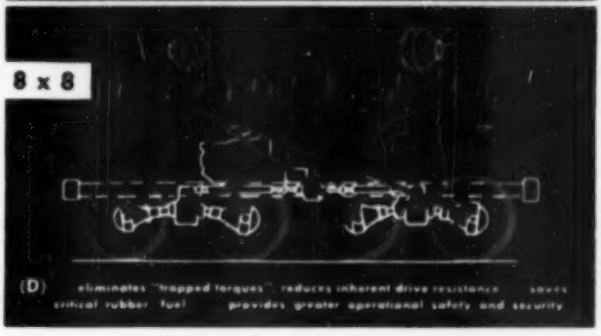
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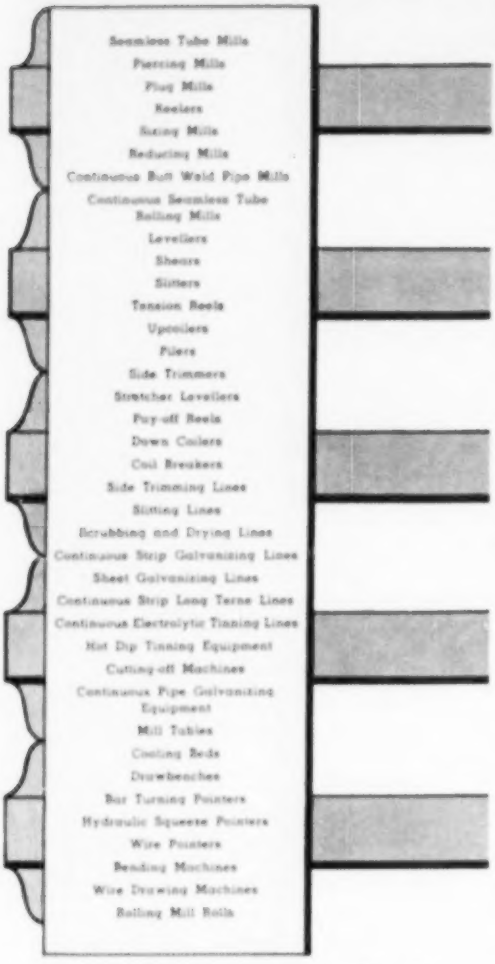

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COMMUNICATIONS

TACTICAL AIRCRAFT IN WORLD WAR II

THE EDITOR:—There was only one really successful tactical airplane in the U.S.A.A.F. during the Second World War. This airplane had the same characteristics which will be necessary in a tactical airplane in any future war:

1. It was extremely hard to knock out of the air and even if extensively damaged it could generally return to base.

2. It was able successfully to defend itself against the best fighter aircraft the enemy had (with the exception of jets which were almost never encountered).

3. It was able to carry a heavy pay load (up to 3,000 pounds of bombs and 2,400 rounds of caliber .50 ammunition plus rockets if equipped for them).

4. It had a reasonably long range.

This plane, of course, was the P-47 (now the F-47) with that wonderful radial engine that brought you home even with two cylinders shot off. By comparison, one bullet in the cooling system of a P-51 gave you about thirty seconds to find a field.

There were a number of targets which were hard to hit with bombs or rockets, but tanks were not such a target. It is true that our infantry found a reasonable number of abandoned undamaged German tanks. Every infantryman I talked to who had seen both the damaged and undamaged tanks expressed it this way: "The Germans were so scared when they saw those P-47's they drove the tank off the road and bailed out." For further information along this line I suggest you look up the records of the 79th Division during the crossing of the Rhine. In half a day the P-47's destroyed over forty tanks.

Those eight (not six) caliber .50 machine guns were mighty fine weapons and very versatile, although frequently against personnel their effect was mostly psychological (this was particularly true when the personnel were in wooded areas). It was primarily for this reason that every fifth round of ammunition was a tracer, and every effort was made to follow up a strafing attack with an infantry attack within fifteen minutes.

While the effect of a strafing attack on a group of men varied with their morale and the ability of their officers, we arrived at a rough rule of thumb to the effect that no resistance would be met up to fifteen minutes after a strafing attack, scattered resistance up to half an hour, and if the strafing was not followed by ground attack within two hours it might almost as well not have taken place.

As far as bombs were concerned we had two which were outstanding. A 500-pound general-purpose bomb with a tenth of a second delay fuze could do a lot of damage to a tank or anything else it hit. An experienced pilot who was not afraid to take it down close to the ground could put it almost any place he wanted to. The number of German tanks destroyed with 500-pound G.P.'s must number well up in the thousands.

A 150-gallon belly tank full of napalm if delivered properly would cover an area roughly the size of a football field with an extremely hot and sticky fire. This could be used on tanks, pillboxes, and personnel, and was especially effective for putting a battery of guns out of action. This little gem had no predictable flight path, and it was useless to try to hit something from over 200 feet altitude, but if delivered from about 50 feet it was practically impossible to miss with it.

If you wish further indication of the effectiveness of the fighter-bombers during the late war I refer you to the classified reports of interviews with captured German officers regarding

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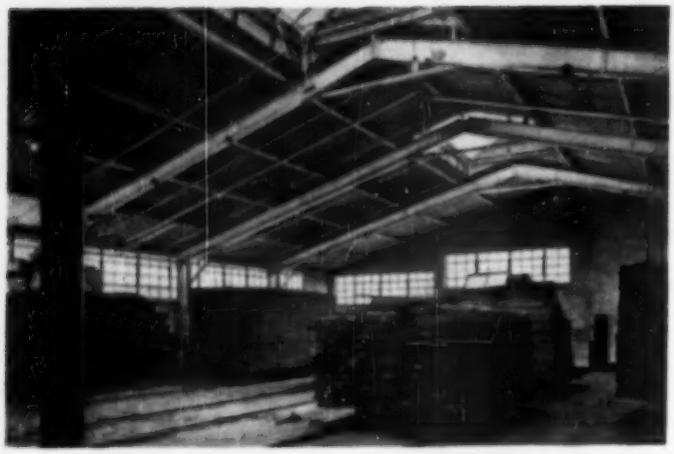

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their effectiveness. Many high-ranking officers of the German armed forces attributed the success of the invasion of Europe and our ultimate victory to them.

I cannot close without a comment on the gyroscopic bomb sight for fighter-bombers. These sights were installed on our planes after the war was over. While I never saw any one who could hit anything with them, I believe that on a clear, calm day with lots of time and no opposition an experienced man might be able to score hits occasionally. These conditions seldom prevail in combat, and it is my guess that any one who held a course and flew the plane coördinated for as long as is necessary with this sight over a worthwhile target would not live long. I am referring here to the relatively low-altitude bombing necessary to hit small targets.

LLOYD W. JOHNSON

Havertown, Pa.

INTELLIGENT

THE EDITORS—I have noticed that the articles in the magazine have become much more interesting and intelligent in their approach. Congratulations! I sincerely believe that a good number of the services' problems can be easily solved by industry when they are intelligently presented.

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Chicago, Ill.

TREASON AND PROPAGANDA

THE EDITORS—Your excellent review of "Seeds of Treason" in a recent issue of ORDNANCE leads my mind back to the days when the magazine was conducting such a noble fight against the pacifists as then exemplified by the Nye Committee. We knew then that the danger was real, but few believed us.

The sad thing is that supposedly intelligent men and women fall for such blandishments. A group of my students at that time intercepted an automobile load of pacifist propaganda sent from a neighboring university as part of an effort to found a group here. Fortunately I was able to destroy this attempt as my students had been previously indoctrinated by me. My sincerity has never been questioned by my students.

From what I know of our so-called "intelligentsia" I often wonder what is wrong with education in general. Since 1918, when I first learned of the seriousness of the situation, I have been trying to do something about it.

You have hit the nail on the head in your review just as you did in your editorials twenty years ago. I was able to gain effective results then by distributing reprints of your editorials.

CARROLL D. BILLMYER

Kingston, R. I.

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Tube can be formed into a multitude of shapes with economy. For instance, the ends can be spun to a smaller diameter —ending in a taper or in a round end entirely closed or partially closed. The tube can also be made with a bead around the circumference. In a word, the Wolverine Spun End Process offers opportunities for a wide variety of end treatments of tube and can save you the cost of extra parts that you now think seem necessary. And besides, eliminate assembly costs.

Our new brochure, Spun End Tube, is just off the press. Would you like a copy to acquaint you with possibilities for greater economy and efficiency that are within reach just by making a slight change in the design of a part?

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Spun End Process is a patented process RE 23465.

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Would you rather have us do the fabricating to your specifications from our seamless, nonferrous tubing and ship the finished parts to you? Perhaps you would like to check with our Customer Engineering Service to assure yourself that your fabricating practice is producing the parts most efficiently.

Keep in mind that our business is the manufacture of tubing exclusively. Call on us any time you need information on tubing fabrication.

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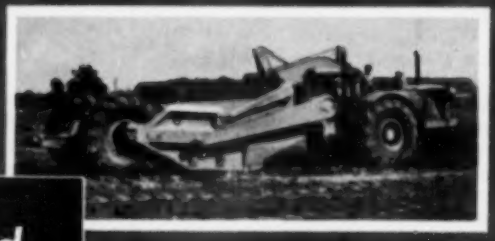

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Here are typical reports on the DW20-W20 unit (25 cu. yds. heaped capacity): "You can run away from other rigs with it," says Operator Robert England. "The dump control is handy and easy to operate. It's got good brakes—you can stop it still, loaded. It's safe on turns and grades. It shifts easy and fast. The engine's got guts." Dragline Operator R. D. Johnson adds: "It's good and

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Accurate hydraulically controlled dumping with positive mechanical lock on dump doors.

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'Dozer-type ejection for positive "kicking out" of sticky material; dependable spring-action ejector return.

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Double bottom of special alloy steel. Self-sharpening, reversible cutting edge.

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Guided Missiles

Mr. K. T. Keller To Direct National Program

THE appointment by the Secretary of Defense of Mr. K. T. Keller to be director of the guided-missile program at this crucial hour in our Nation's history is cause for satisfaction throughout the land. The announcement of the appointment has been received with general approbation.

"Push-button warfare" can easily become a delusion. Our sad experience in Korea has shown again that there is no easy, automatic way to win in modern battle. All the more reason to take stock of the tremendous demands in the newer fields of military research and development. They require the highest coördination in order that best results may be attained for the fighting services—ashore, afloat, and aloft.

Coördination Applied

Timely indeed is the reassuring announcement of Mr. Keller's participation in the guided-missile program. It indicates to the country that a practical and realistic coördination will be applied. It is tremendously important that energies be not wasted in these crucial days. Whatever progress has been accomplished thus far—and it is by no means slight—there is need for coördination in order that American lives be saved. The successful operation of the guided-missiles program can go far toward achieving most desirable results.

The direction of such a program requires the highest quality of leadership, first-rate administrative ability, and a thorough knowledge of men and machines. Mr. Keller, chairman of Chrysler Corporation, possesses time-tested qualifications for the assignment in eminent degree. He has built up over the years a rich store of knowledge and experience. He is a man of courage, patriotism, and vision.

He began his career as a machinist at the lathe. His advancement parallels the growth and development of the automotive industry itself. In one of the most competitive areas in American economic life his sound social sense and technical ability have won ever-widening recognition until he became what he is today—one of the leading figures in American industry.

Mr. Keller, by reason of his lifelong association with the automotive industry, has made a generous and significant contribution of lasting value to mankind.

His wartime record is equally distinguished. He will always be remembered in the annals of our national defense as the man who, in less than one year, directed the planning, building, and outfitting of a mammoth tank arsenal for the United States Army and completed production of its first tank with record speed.

Built Tank Arsenal

The building and operation of the Detroit Tank Arsenal alone was a demonstration of great skill. Speaking of it in an address to the Army Industrial College, Mr. Keller said: "How widespread this (the use of subcontracting) is may be illustrated by the Detroit Tank Arsenal. This job represents materials, supplies, and finished goods bought direct from more than 700 individual companies located in 130 cities in 20 States. When all the individual suppliers to the 700 concerns from which we buy are added together, you can see that our tank-manufacturing job alone engaged people in large and small companies all over the land."

Mr. Keller was a member of the personal advisory staff of Lieut. Gen. Levin H. Campbell, Chief of Ordnance of the United States Army, and served in this important capacity until the conclusion of hostilities. In addition to his outstanding Ordnance service, he and his company were most helpful in the production programs of our Navy and Air Force.

For many years Mr. Keller has been a director of the American Ordnance Association. He has been cited by the Association and awarded its Gold Medal for Merit. He is also a leader in numerous humanitarian and cultural enterprises, and represents the highest type of American citizenship.

The country is most fortunate, in this hour of grave peril, in having Mr. Keller in a post of extraordinary responsibility where his unrivaled ability can contribute so much to the common defense of the United States and to the survival of all freedom-loving people everywhere.

In awarding the Levin Campbell Gold Medal to Mr. K. T. Keller in 1949 the American Ordnance Association cited him in these words:

"For distinguished service in the design and quantity production of superior ordnance for the armed forces of the United States—ground, sea, and air. With inspiring leadership he marshaled scientific, engineering, and industrial strength for certain victory in war; with penetrating vision and constant zeal he has sustained the active peacetime program of the American Ordnance Association for the advancement of national preparedness. Production engineer, industrial statesman, humanitarian, and patriot, Mr. Keller is acclaimed by the American Ordnance Association for his tireless efforts for the security of our country by providing the tools to protect American lives and to enforce peace."

DAWN'S EARLY LIGHT

finds technicians at the White Sands Proving Ground, N. Mex., preparing a V-2 rocket for a test flight.

We must back up intelligent leadership with armed forces in being

THE CHALLENGE OF 1950

Gen. Clifton B. Cates
Commandant, United States Marine Corps

THE American Ordnance Association has taken the occasion of its Thirty-second National Dinner to honor the U. S. Marine Corps. We consider this a mark of appreciation for service rendered by our Corps, and since the Marine Corps exists only to serve this Nation, we are very grateful for the tribute.

It is a well-known fact that the American Ordnance Association is an "organization of American citizens dedicated to scientific and industrial preparedness for the common defense." I commend you on the high purpose of your group and the extent to which your goals have been achieved. In combining and directing your efforts toward the common defense of our Nation, you have given form and substance to an obligation and responsibility of every American citizen.

Many Contributions

You can well be proud of the contributions which you have already made to our country. These are, in no sense, limited to the ordnance matériel which you have developed and manufactured. Many members of your group have made direct contribution of their time and talents, one being Mr. K. T. Keller, who only last month acceded to the request of the President and of General Marshall to direct our guided-missile program.

The year 1950 has been a significant one in the course of man's struggle for freedom. In June came the shock of our entry into the Korean conflict—a decision which we could not, in all conscience, have avoided. There was first the sobering effect of initial battlefield reverses which rapidly changed to optimism when victory seemed within our grasp.

Recent Pessimism

Recently this was even more rapidly replaced by pessimism when the Chinese Communists entered the battle in full force. And now with the Chinese riding a Red tide of victory and our own forces withdrawing on all sectors of the Korean front, there is deep gloom and no little despair.

Were I in any way to minimize the extreme gravity of our current predicament, I would do you and this country a distinct disservice. It may be that we are on the verge of a great war. I do not know—and no man knows. The leaders of our Government and those of our allies are exploiting every possibility of a reasonable settlement for peace.

While hoping for their success and giving them every ounce of moral support we can muster, we must not fool ourselves. This might well be the most critical period in the history of America—and of the free world. It is a time for sober thought, a time for men to summon their courage and their faith. It is a time for men to move with the most resolute action of which they are capable. . .

This is an appropriate time to take a critical look at what we have done, what we have tried to do, and what we must do in the future. . .

The men who are making sacrifices in Korea have the right to expect that you and I are doing the very best that our knowledge and ability will permit. I think we should find our mistakes and admit them freely and without rancor. We should not do this to find a scapegoat; we should do it objectively to improve our common defense and to guarantee our chance for survival.

Above all, we must be realistic. Idealism is fine, but it must not obscure the facts. This is a time most certainly to face our responsibilities squarely and plot our course on the basis of a forthright determination of the essential things we must do to insure the future of our Nation and of the free world. But we must first decide what is essential, as our resources have limitations and will not permit diversion to every part of the world.

Profit by Mistakes

It is not my purpose to plead a partisan view or to become involved in any controversy. Errors have, of course, been made, but recriminations serve no useful purpose. What we must do now is to profit by our mistakes and get on with the job. It is well to remember that the common defense is a joint responsibility in which we all share, whether it results in victory or defeat.

You will recall what has been said about some men "having greatness thrust upon them." I think that history will show 1950 as the year when the opportunity for greatness was thrust upon our Nation. We are, willingly or not, in the spotlight in the center of the stage.

Energetic, intelligent leadership by this Nation can bring the peace we all seek and the opportunity for free men to live in the manner of their own choosing. If we fail to supply this leadership, then the future will be dark indeed.

This is the challenge today. To my mind the question is, will we measure

General Cates delivered these remarks at the Thirty-second National Dinner Meeting of the American Ordnance Association held at the Waldorf-Astoria, New York City, December 6, 1950, in tribute to the United States Marine Corps on the occasion of its 175th anniversary.

up to it? Will we demonstrate the courage and determination to see it through? Will we be willing to pay the price in lives, time, effort, and money that this leadership demands? Personally, I see no choice since the alternative could be disaster. But the issue of whether America can be sufficiently realistic to discharge the rôle of world leadership is still not settled. This is a challenge to all Americans and not just to our Government officials.

Almost a year ago we entered 1950 with high hope. We seemed to be well advanced in an era of great prosperity. More than sixty million people were working for more money than ever before. Automobiles, refrigerators, and television sets were being manufactured at a rate that changed production curves into nearly vertical lines.

Possibly we were preparing our people for many things—but certainly not for the adequate defense of this country. The fact that forty four per cent of the young men who report for the draft are physically unqualified would seem to indicate that the average American boy leads something less than a Spartan existence! This weakness, in my opinion, is one of the most serious problems confronting us today.

We were doing even less to prepare our people mentally and emotionally for their tasks in the common defense. The whole problem of America's rôle in world leadership and of our national-defense position had been assigned to "George" by default. "It should be done," we said, "but let George do it."

Committed to U. N.

Internationally we were carrying out the Marshall Plan and the Military Assistance Program. We were committed to the United Nations as an instrument of world peace—certainly one of the soundest moves we have ever made. However it is unfortunate that too many Americans viewed the formation of the U. N. as an end in itself. They forgot that it was only one step in the direction of peace. It did not mean that there would be peace automatically. This should have been anticipated, as the average American citizen always finds war and talk of war distasteful.

This same feeling was reflected in the state of our armed forces. We had seriously curtailed the size and striking power of our services when viewed in the light of our world-wide commitments.

I think we could look on the money we spent maintaining our armed forces and their related activities as premiums paid on essential life insurance. In this case we had, in effect, converted all our annuities and participating policies into term insurance in order to reduce the premiums. We had even cashed in some of our policies by using up our war-reserve stocks for routine operations. We were paying minimum premiums and laying aside nothing for contingencies. In some ways we were living off our principal.

In the field of ordnance, where you are particularly concerned, we were largely restricting our purchases of new equipment to prototypes. We were not willing to pay the added premium that would have stock-piled new weapons and ammunition prior to June 25, 1950.

This is not criticism of you who manufacture ordnance or of the people who set the quantities to be bought. It is merely an acknowledgment of a feeling that was prevalent throughout the country. We were all trying to get by on as little as we possibly could. It was a calculated risk, and our Korean experience has shown that the accuracy of our calculations left a great deal to be desired.

I would not attempt here to fix responsibility for these shortcomings because I believe that it properly belongs to all of us. We just were not facing the issues squarely. We had lulled ourselves into a false sense of security, and Korea has shown that we were very near a grave world crisis.

Must Fight for Peace

This trend was brought to a sharp halt when we entered the conflict, and our thinking has been clearer since we recovered from the cold-water shock of that decision. What we found out was what we should have known all along—that, under some circumstances, we have to fight to have peace.

When the magnitude of our task in Korea became clear it was apparent that the state of our common defense was such that drastic action was required.

Our experiences in the Marine Corps closely paralleled those of the other services, and I believe you will be interested in a brief summary of what has gone on in our service. On June 25, 1950, our Fleet Marine Forces—the combat elements of our Corps—consisted of two Marine divisions and two Marine aircraft wings, all at reduced strength. These were organized on a basis of what we called peace tables of organization, but their actual strength was far below even the meager figures of those tables. We only had 27,000 Marines in the entire Fleet Marine Force. Had our units been at full war strength, the total would have been approximately 60,000. What we had were well trained, in a high state of readiness, and organized for rapid expansion in an emergency.

General MacArthur's first request for Marines was for a regimental combat team with supporting air units. Upon the approval by the Joint Chiefs of Staff we organized the 1st Provisional Marine Brigade composed of the 5th Marine Regimental Combat Team (at reduced strength) and the Marine Air Group 33.

Orders were issued on July 5th and the brigade sailed from the West Coast nine days later. Before the end of July our commitment had been raised to a full war-strength division and a Marine aircraft wing. To meet this we utilized every trained Marine avail-

History will show 1950 as the year when the opportunity for greatness was thrust upon our Nation. We are, willingly or not, in the spotlight in the center of the stage with the world as our audience.

able. Practically all the troops from our 2nd Division in North Carolina were transferred to the 1st Division in California. One infantry battalion which was afloat with the Sixth Fleet in the Mediterranean was even sent to Japan by way of Suez, the Indian Ocean, and the East China Sea.

Trained Reserves

By using every available Regular Marine, we still would not have had the 1st Division at required full strength had it not been for our trained Reserves. It is impossible to overestimate the value of these Reserves to our national defense. They have been one of the few bright spots since World War II.

In fifty-three days we mobilized all our organized ground Reserves and a small part of our air Reserves. We were forced, by press of circumstances, to send some of these men with the 1st Marine Division to Korea. We set up a screening process to select those best qualified, and the men who went, in the responsible judgment of our field commanders, all had the required training for the jobs to which they were assigned. I can tell you that these officers and men, who were in civilian life a relatively short time ago, are performing magnificently in combat in Korea.

As a result of these efforts we had 31,000 Marines in Korea at the time of the amphibious assault at Inchon on September 15th. This is significant when compared with the 27,000 in the entire Fleet Marine Forces last June.

The Army, Navy, and Air Force have all had similar experiences. It is reassuring to know that all the services reacted so well under pressure. But we cannot escape the fact that it should not be necessary to expand and organize our combat units so rapidly, nor can we deny that we might not be able to do it again.

There seems to me to be clear proof that we must have ready and mobile forces of such size as to insure time for an orderly mobilization.

In surveying the field of ordnance, I believe we will find a uniform pattern of good results. This is particularly true in research and development. A good many of you have given your efforts and those of the agencies you represent to the development of ordnance matériel. . . .

I think you have every reason to be proud of the ordnance of our armed forces today. Recently I made a trip to Korea and spent some time with the 1st Marine Division. I talked with battalion, company, and platoon commanders and with squad leaders and section chiefs.

"I think you have every reason to be proud of the ordnance of our armed forces today."

No designer, no manufacturer, no general has more interest in good ordnance than the troops who use it. These men, after all, are the final judges, and their verdict today is that on the whole our weapons and equipment are superior or equal to those of any other nation.

Perhaps you will be interested in the opinions of our men on the antitank weapons with which they are equipped. They are completely confident of their ability to handle tanks of the T-34 type. Our Marine units in Korea have the M-26 Pershing tank, and the 90-mm. gun mounted on that tank is their Number One antitank weapon. Next in order of preference is the 75-mm. recoilless rifle; then the 3.5-inch bazooka.

Improve Weapons

To say that what we have now is good enough to cope with the enemy so far disposed against us is not to say that our weapons could not and should not be improved. The problems of increasing the shocking power, accuracy, penetration, and range while reducing the size and weight are still with us and always will be.

I hope that we will all remember that before a weapon can have any effect on the enemy it must be in the hands of the man in the front line. It is very little help to him to know that the weapon he needs now is on the drawing board. He knows nothing and cares less about "lead time." He knows only that when the chips go down either he has the weapon or he hasn't. If he hasn't, he feels betrayed—and with good reason.

If we, as a nation, are to assume leadership of the free world, we must, in my judgment, have armed forces in being which permit us to make our will felt wherever our interest is threatened.

We must have an Army with forces in being for early commitment and an adequate mobilizatson base for the forces required to make the final conclusive effort in any war.

We require an Air Force composed of both strategic and tactical aviation, with planes ready for take-off, not in the minds of designers.

We must have a Navy which can control the seas and project seapower against the enemy with ships and aircraft at sea—not in moth balls.

We need a Marine Corps of combined arms—ground and air—which provides a highly mobile, amphibious trained force in readiness for instant deployment. Recent events have proved the need for these requirements beyond a shadow of a doubt.

Implement Plans

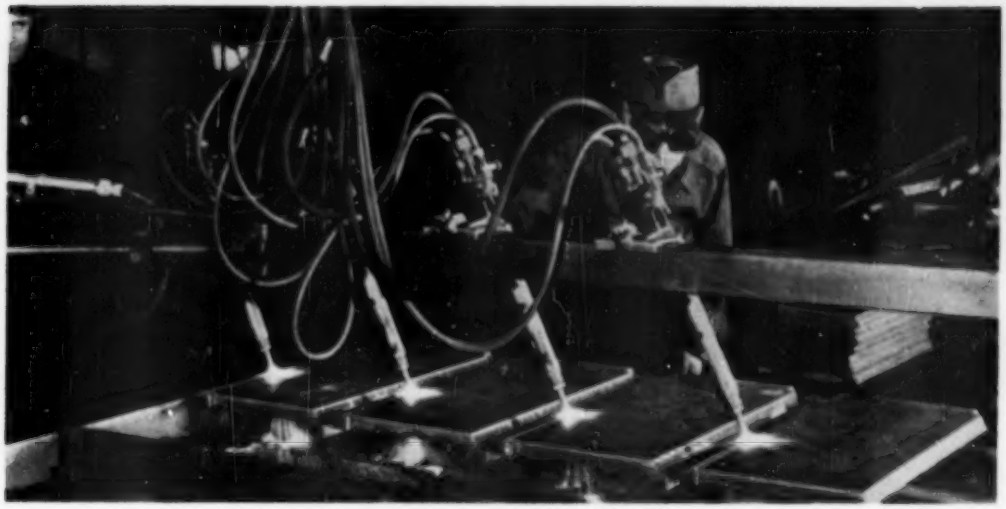
The plans which have been approved to date will provide these things at what I consider to be minimum levels. These plans should be carried through—not pruned and cut as the winds of our willingness to pay for preparedness blow hot and cold.

Victory may come in the halls of the United Nations or on the field of battle. But it will come only if the American people face their responsibility and hold steadfast to their purposes.

It can come, in my opinion, only if we accept the challenge of 1950 and provide the free world with aggressive, intelligent leadership which bases its divisions on frank and realistic appraisal of facts.

We must back up that leadership with armed forces in being of a size commensurate with our responsibilities, and these must be supported by an informed American public.

Above all, we must have unity on the home front and the willingness to make heavy sacrifices for our country.



Smaller War Plants

The Conversion of Small Plants through Subcontracting

M. B. Hammond

Experience gained from the manufacture of armor plate in the last emergency may serve as a valuable guide to small plants in the future

FEW subjects in our time have received the attention that has been given to "smaller" plants and their relation to a war effort. The reasons for this attention are obvious, there being in our country so many such plants. Let us define a "smaller" plant as one which has been deprived of peacetime raw materials or markets through war regulations or requirements and which suffers serious curtailment or shutdown. A smaller plant does not become such until it is in operation for the war effort.

Let us also consider another type of plant. It is one that moves from peacetime production to war production with little problem of plant shutdown. The problems of this type of plant are associated with too much required production. Thus it is easy to see that this second type plant is in an entirely different category from the first type. Of course there are intermediate cases, but all will generally tend in one direction or the other.

Therefore, we will consider plants which are distressed or which are becoming distressed and plants which are not distressed and have reason to believe that they will not become distressed due to the general conditions prevailing prior to or during a war emergency.

There are certain definite characteristics which comprise these two general types of plants. In the former type of smaller plant there probably is little, if any, peacetime Government contact. Also there probably is little or no research accomplished in conjunction with Government requirements and projects. In the latter type plant, contact and research with Government agencies are probably maintained during peacetime.

Mr. Hammond is vice-president of Standard Steel Spring Company, Coraopolis, Pa.

Loss of Production

When the total impact of war develops, these two classes of plants become separated by an ever-widening gap which in essence is a distortion of our over-all economic system. Accompanying this widening gap is loss of production, manpower, purchasing power, and a host of other things just at a time when they are most needed.

One might think all that is necessary for a smaller plant to be sure of work in a war emergency is to maintain Government contact during peace. This is not necessarily true, because smaller plants by their very nature often make only a few products, have a relatively small number of employees, and usually employ but few processes.

They are therefore limited in their usefulness in single instances as far as the Government is concerned.

On the other hand, major plants usually make a wider variety of products and use more processes. They frequently utilize processes, equipment, and skills not available elsewhere. The advantages of larger plants to Government agencies are quite obvious for in each organization lies opportunity for coördination and assembly of war production which might require many components and make use of many processes as well as capital, expenditures, research, and development.

It may be profitable to compare the large and small plants from another angle, too. Smaller plants usually consist of much individual initiative, are flexible, are able to make fast decisions, and can move quickly plantwise and projectwise. They usually contain more individual general skills. Smaller plants cannot be shut down due to internal or external reasons as quickly as large plants. Here, then, are represented certain advantages in quick changeover, versatility, resourcefulness, and ingenuity.

In a large plant much time is required to make decisions, and there are usually many committees which must be satisfied before a move can be made. Generally there is considerably more inertia and resistance to change of process, equipment, and personnel in a large plant than in a smaller one.

Best Use of Plants

How can more profitable use be made of the equipment, processes, manpower, initiative, and resourcefulness of smaller plants to decrease the strain on the assets and facilities of large plants in wartime? Let us remember that in the early phases of total war the smaller plant is grinding to a stop while the large plant is usually stepping up production rapidly.

A partial answer lies in certain companies taking the initiative and forming teams among the smaller plants. Such a company could well be one of the smaller plants. The initiating company must be willing to lead, negotiate, and take risks along with the entire team. It must make available to the other smaller plants a plan of operation and guidance and a plan of action based upon an understanding of equipment, processes, and personnel for any given project or projects. This company must acquaint itself with governmental requirements and war production needs and be able to translate them into production on short notice.

Such a plan was developed and demonstrated by the Standard Steel Spring Company in the Second World War and is outlined here to provide an example for the utilization of smaller plants in war production.

The Standard Steel Spring Company was established in 1914, its chief product being springs for vehicles. As the automotive, agricultural, and industrial activities of our country developed, the company associated itself more actively with these fields. When World War II was in the offing, Standard Steel Spring products were automotive bumpers, springs of all types and designs, steel floor grating, and universal joints. Prior to the war the company's plants were all operating at capacity.

Steel Manufactured

Because of the nature of its facilities and products, the Standard Steel Spring Company dealt chiefly with steel in one form or another, and its processes included heat-treating, forming, grinding, and machining. Prior to Pearl Harbor, the company management began investigating Government needs and requirements along certain definite lines.

The plan adopted for the greatest utilization of company facilities was that some product be found which the Government required in quantity and which would fit the plant equipment and personnel. After much exploratory work with the Army, Navy, and Air Corps, covering a host of different items, it was determined that armor plate seemed to fit the facilities best.

There are three definite steps to be taken in preparing to convert a company to war production: (1) A careful survey of Government requirements, (2) close evaluation of the company's facilities, and (3) determination of a lowest common denominator of these facilities.

I wish to stress at this point that there were three definite steps taken: (1) The careful survey of Government requirements, (2) the close evaluation of company facilities, and (3) the determination of a lowest common denominator of these facilities (which happened to be heat-treating).

Studied Armor Plate

The company then began an intensive investigation of armor-plate manufacture. It was a difficult subject because not much had been written about it other than Krupp's description, and the processes usually were secret for security reasons. Requirements also were hard to estimate because no one knew too definitely the type and size of projectiles which would be used in the ensuing conflict. However, work with Government agencies and proving-ground approvals on the armor plate processed soon gave confidence.

Being new in this field had certain advantages among which was the fact that Standard Steel Spring didn't know all the things that could not be done. Consequently it began with the idea that armor plate could be made which contained much less of the critical metals.

Work with Ordnance and the steel companies resulted in the development of steels with good ballistic qualities and with a minimum of alloys. Because these steels contained no really critical elements they proved to be a boon to production, and they were easier and quicker to handle in heat-treating, quenching, and machining.

Because many of the Standard Steel Spring customers were in the automotive field, the company quite naturally secured armor-plate orders from this source. These requirements almost filled the capacity of all available plants. Shortly after receiving these initial orders, representatives of the Standard Steel Spring Company went to Washington to discuss matters with Ordnance. Here they were told they would have to produce additional

armor plate for other manufacturers.

Before long, several other prime contractors of tanks and other vehicles also called upon the company for armor plate.

At about this time the Standard Steel Spring Company had far more business than it could handle in its own plants so elaborate plans for a new armor plate manufacturing plant were prepared. These plans were submitted to Ordnance, but when Ordnance officials saw the plans they said there wasn't time to build plants since Ordnance needed armor plate immediately.

Ordnance had done a lot of planning, and the tank and combat section under its able leadership provided inspiration and courage. Ordnance officials told the Standard Steel Spring Company that it would have to form a team and get going quickly. When asked how to do this, they suggested, "Get your competition together." This was done, and the response was most enlightening and encouraging. Officials of Standard Steel Spring Company knew the equipment and facilities of the competing companies and knew that their facilities would fit Standard Steel's lowest-common denominator—heat-treating.

Competitors Surveyed

Surveys of competitors' plants showed that they had excellent possibilities and, with some small supplemental equipment, could get into armor production quickly. With the addition of flame-cutting and machining equipment, it wasn't long before all were producing armor plate in quantity.

But orders continued to come in and increased at a rapid rate until the list of competitors had been exhausted. Standard Steel Spring then turned to another group of plants which were shutting down because of war pressure—the stove industry. They, too, had the required factor—heat-treating. Next the porcelain enamel companies and, finally, a shovel company, a railroad car building company, an automotive frame manufacturer, and a brick kiln were included in the group of subcontractors. The establishment of the lowest common denominator made survey work much more simplified.

By now the need for a closer-knit over-all organization centrally located had been recognized, and a central office was set up in Detroit, Mich. This central office was the nerve center for the entire program. Facilities were built up to produce 38,000 tons of armor a month.

"With the enthusiastic coöperation of the subcontractors, the assistance and coöperation of Ordnance and the prime contractors, quality goods were produced in volume, on schedule, and at a truly low and competitive price."

One thing was an absolute necessity in this program—control. The partners had to be instructed, guided, surveyed, and subjected to quality control. They needed financial assistance. They needed firm orders and other assurances of a business nature. Standard Steel Spring Company's control consisted of certain definite items: (1) control of steel (it purchased and retained title to all the steel), (2) control of production and schedules, (3) control of inspection and quality, (4) control of cost, and (5) control of metallurgy, processes, and ballistics.

The Standard Steel Spring Company produced armor plate in a very short time after its rapid start; produced it in quantities and on time for the manufacture of vehicles and guns. It produced armor of an unexcelled quality and at a highly competitive price. There were thirty-one partners in the Standard Steel Spring Company program, and together they supplied eleven prime contractors with many forms of armor plate which were, in many cases, developed by Standard Steel Spring or by subcontractors' plants.

One of these developments was formed armor. By producing pieces of irregular shape, considerable welding was eliminated and the total over-all weight reduced as well as the parts required.

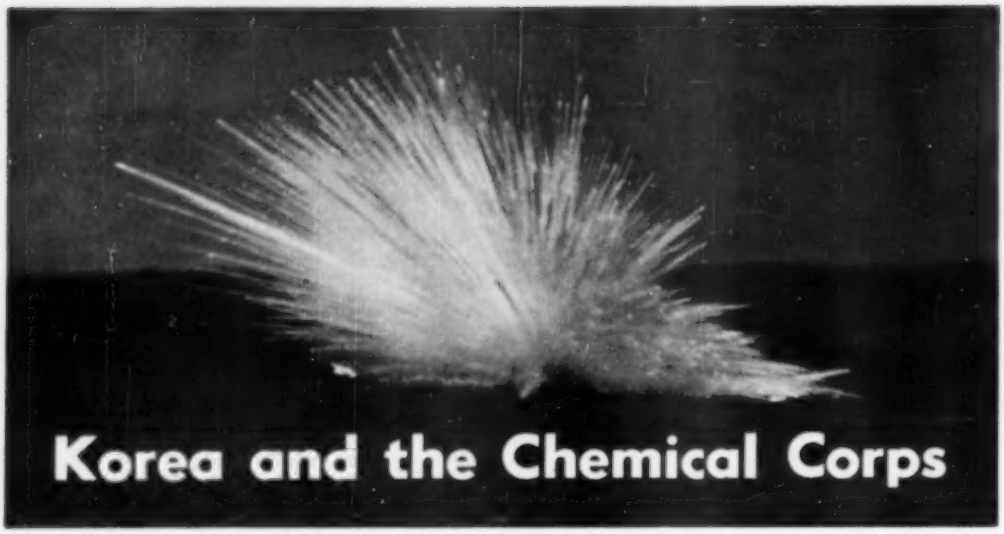
While busily engaged producing armor for the war effort, Standard Steel Spring was advised that the Government would look to it for heavy-duty truck axles, transfer cases, and axle chassis units. From what has been said, it was easy to see that the organization of Standard Steel Spring Company was already spread quite thin. It was a little difficult to see how such a great project could be undertaken, but, upon the insistence of Ordnance, it was accomplished.

The pattern for the axle program was essentially a duplicate of the armor-plate program and proved that the method was sound. First, the lowest common denominator of the operation was found. This, quite obviously, was precision machining, so the matter was studied to determine which group of subcontractors would best fit this requirement. At this particular time the machine-tool people were very slack, and, since they were accustomed to precision machine work, an axle program was formed with subcontractors who had this common denominator. A central office and an axle plant were established at Madison, Ill., in a plant previously used for armored castings.

Similar Controls

The controls used in this program were of a similar nature to those used in the armor-plate program and brought forth production, quality, and service. Here was a different type of work from armor plate. It was necessary to produce axles containing many component parts. The final assembly of axles was done at the Madison plant. Subassemblies were made at some of the subcontractors' plants. In this particular program there were seventeen subcontractors involved.

In the early phases of these programs it must be admitted that there were severe doubts in the minds of Government officials, financial institutions, and others as to the soundness of these undertakings. With the enthusiastic coöperation of the subcontractors, the assistance and coöperation of Ordnance and the prime contractors, quality goods were produced in volume, on schedule, and at a truly low and competitive price. When the programs were over there were no expensive buildings to turn over to the Government, there was a minimum of equipment which had to be turned back to the Government, and there was no displaced labor.



Korea and the Chemical Corps

Increased Procurement Found the Organization Ready

by

Maj. Gen. A. C. McAuliffe
Chief Chemical Officer
Department of the Army

Between July 1 and October 1, 1950, the Corps shipped more than 25,000 tons of chemical matériel to the Korean theater

DESPITE the setbacks suffered by United Nations forces in Korea due to the enemy's overwhelming superiority in manpower it is only proper that we pay fitting tribute to the industrial-military team of the United States for its splendid job of producing, transporting, and using huge amounts of military supplies and matériel on such short notice and at such cost to the enemy. The fact that much of this equipment had to be shipped thousands of miles is an added tribute.

The efficiency of this team can be very readily gaged by a glance at the amount of material of all types shipped into Korea prior to the launching of the Inchon invasion. From July 1st to October 1st these shipments included approximately 123,000 measurement tons of clothing and related supplies; 136,000 measurement tons of food; 607,000 measurement tons of gasoline and related products; over 500,000 tons of organizational equipment; and more than 160,204 tons of ammunition.

These figures do not include thousands of tons of supplies and equipment shipped from Japan and other Pacific bases.

Logistic Problems

The extent of some of the logistic problems of modern war is also shown by the above figures. Today, supply lines extend thousands of miles over land and over vast ocean areas. Matériel must be sent by train, truck, ship, and plane to reach our front-line fighting men. The knowledge that they will receive the necessary supplies and that the home front—industry and the people—is backing them, is the greatest morale builder that any army could have. And we are backed in unlimited measure by both American industry and the American people. That is one of the sources of our strength as a nation.

Industry's Rôle

In two world wars during the first half of this century industry enabled the Chemical Corps to meet its obligations for supplying chemical weapons, munitions, and other items to our armed forces. These mutual relationships now are assisting us to meet the demands of the present situation.

But the relatively complex problems of procurement and supply have expanded to such a degree that we can no longer rest in peacetime lethargy and then jump to wartime production on the spur of an emergency.

It required the experiences of World War II to demonstrate that the most important basic factor in a nation's military strength is its war production potential and ability to convert smoothly and quickly its industry, manpower, and other economic resources.

The Department of Defense, under authority of the National Security Act

of 1947, established the Munitions Board to coördinate, in addition to other phases of over-all plans, the military phases and aspects of industrial mobilization.

Surveys Made

Surveys have been made of the industrial capacity of the Nation, and specific planning schedules for mobilization production have been worked out between the various technical services. These plans are based on priorities established by the Munitions Board to govern the allocation of industrial production when it is geared to war production.

But let's be specific and look at the industrial-mobilization and procurement-planning programs of the Chemical Corps. We can thereby gage the effectiveness of these plans to some extent when military procurement is suddenly accelerated as during the present U. N. police action in Korea supported by U. S. forces.

The Chemical Corps has been allocated certain industrial capacity of the chemical industry to meet its responsibility for supplying chemical matériel to other branches of the Department of the Army and, upon request, to the Navy and Air Force. Requirements of these services are computed on the troop basis for mobilization.

This single-agency procurement responsibility is designed to eliminate competition such as existed between the various services in the early stages of World War II.

To preserve industrial know-how acquired during World War II, the industrial-mobilization program of the Munitions Board is divided into four categories: (1) maintenance of reserve plants; (2) acquisition and maintenance of essential machine tools and manufacturing equipment difficult to obtain in an emergency; (3) planning studies and industrial-preparedness measures with industry; and (4) planning within the Department of Defense.

Requirements Analyzed

Chemical Corps requirements are carefully analyzed on the basis of past experience with the chemical industry and a detailed analysis of the industrial facilities of the Nation. Tentative procurement schedules are then placed with the Corps' six procurement districts, whose offices are located in Boston, New York, Atlanta, Chicago, Dallas, and San Francisco. Potential prime contractors with industrial facilities capable of producing desired end items of chemical supplies and equipment are then contacted by these procurement-planning offices to work out plans involving their facilities.

In the planning stage, chemical procurement districts maintain close collaboration with designated industrial plant managers in preparing production plans for the manufacture of specific items. These districts also assist in the administration of various industrial-preparedness contracts which have reduced production "lead time" in numerous cases.

Preliminary allocation of a plant's industrial capacity is obtained from the Munitions Board by local armed services procurement planning officers known as ASPPO's, who may be representatives of any branch of the Department of Defense or of the technical services. When plans are completed between industrial plant managers and the Chemical Corps, final allocation plans for end-item production are agreed upon by the two parties.

These plans are then submitted to ASPPO's and, if satisfactory, the Munitions Board confirms, through the General Staff and the Chemical Corps, allocation of the plant's industrial capacity for emergency production. An exception to this procedure takes place when conflicts arise among the military departments or where production bottlenecks exist among potential subcontractors. The matter is then handled by the Munitions Board.

Since V-E Day, procurement districts have been engaged mainly in procurement planning. However, some of them have now received actual procurement authorizations. For instance, at the present time the Chemical Corps is in the process of authorizing the Boston, New York, and Dallas Chemical Procurement Districts to procure some items of chemical munitions and other supplies.

Address Districts

Manufacturers interested in actual procurement or procurement plans of the Chemical Corps in those areas should address inquiries direct to the district office in which their business is located. That district office will furnish information regarding procurement plans in its area as well as procedures and regulations of the Munitions Board.

Because of the load placed upon the Department of Defense by Communist aggression in Korea and the expansion of our defense forces here at home, all potential contractors are earnestly requested to contact procurement districts directly regarding production of defense items. To visit Washington would be a waste of time, money, and effort.

A new regulation was recently issued by the newly established National

Signal Corps

Flame thrower in action against a pillbox.

Production Authority which is responsible for the priority rating of defense contracts. This order, known as NPA Regulation No. 2, has already gone into effect.

"DO" Orders

Orders for the Department of Defense or its agencies are identified as "DO" orders. Authority has been delegated to the technical services which in turn authorize local procurement officers to designate the priority of contracts now in effect and of new contracts. Exceptions exist, however, as provided in list "A" of NPA regulations and in any additional list which may be specified by the Administrator of the National Production Authority.

Priority ratings are issued automatically to prime contractors who have authority to extend basic defense order ratings to subcontracts.

It should be emphasized, however, that the rating system does not change procurement procedure in any way whatsoever.

Now that we have examined procurement procedure, let's look at what effect the Korean situation has had upon the Chemical Corps. The outbreak of Communist aggression in Korea found the annual appropriation bill for fiscal year 1951 of the Department of Defense pending before Congress. The over-all budget was based upon keeping defense expenditures at approximately the same level as for fiscal year 1950.

Congress subsequently enacted this legislation, which provided 37.3 million dollars for the Chemical Corps to carry out its normal peacetime functions. Of this amount, the Corps' industrial-mobilization program funds were approximately the same as for fiscal year 1950. Procurement funds amounted to approximately 10 million dollars to be used primarily for meeting normal issue demands of the Regular Army, for service testing small quantities of materiel, and for the procurement of standard chemical items in short supply.

Following the decision of our Commander in Chief to commit U. S. troops in Korea, the Chemical Corps was loaded down with requisitions for critical supplies needed for combat operations. Despite much advanced planning there was a serious depletion of normal issue stocks such as gas masks, smoke munitions, and training material here in the United States.

Further demands were made upon the Corps by the rapid expansion of task-force troops in Korea and by the replacement of units in the zone of interior.

It soon became evident that additional funds were required to meet these obligations and to replace stocks depleted from some depots.

"Marine pilots generally agree that napalm bombs are the best antitank weapon they've used. Tanks can be knocked out by a hit anywhere within fifty yards."

In accordance with the request of President Truman in his first message to Congress on the Korean situation, Congress passed the First Supplemental Appropriation Bill authorizing additional appropriations for the Department of Defense to support combat operations. Of this amount, 31.5 million dollars was made available to the Chemical Corps. This money is being used principally for the procurement, production, and delivery of chemical supplies and material.

About 20 million dollars of these funds provided the initial increment of critical items used in Korea, such as weapons, ammunition, fuel for flame throwers, smoke munitions and grenades, napalm, smoke pots, and similar chemical supplies. These demands have already increased the Corps' requirements by a factor of 20.

However, since the effectiveness of all planning is gaged in battle, let's see how effective chemical supplies, equipment, and munitions proved in Korea. We shipped more than 25,000 tons of chemical matériel to Korea between July 1st and October 1st. Included were flame throwers, napalm, portable and mechanical smoke generators, and incendiary bombs.

In combat, flame throwers and chemical munitions were used extensively by front-line fighting units in such places as ridges along the Naktong River and elsewhere. Colored smoke was used for marking newly captured airfields. During the amphibious invasion at Inchon, flame throwers were used to good effect by the Marines on Wolmi Island to flush the enemy from underground installations.

In the continued rout of the enemy, five T-34 medium (Soviet) tanks were knocked out by direct hits with napalm incendiary bombs dropped by Marine Corsairs on the road from Inchon to Yondong.

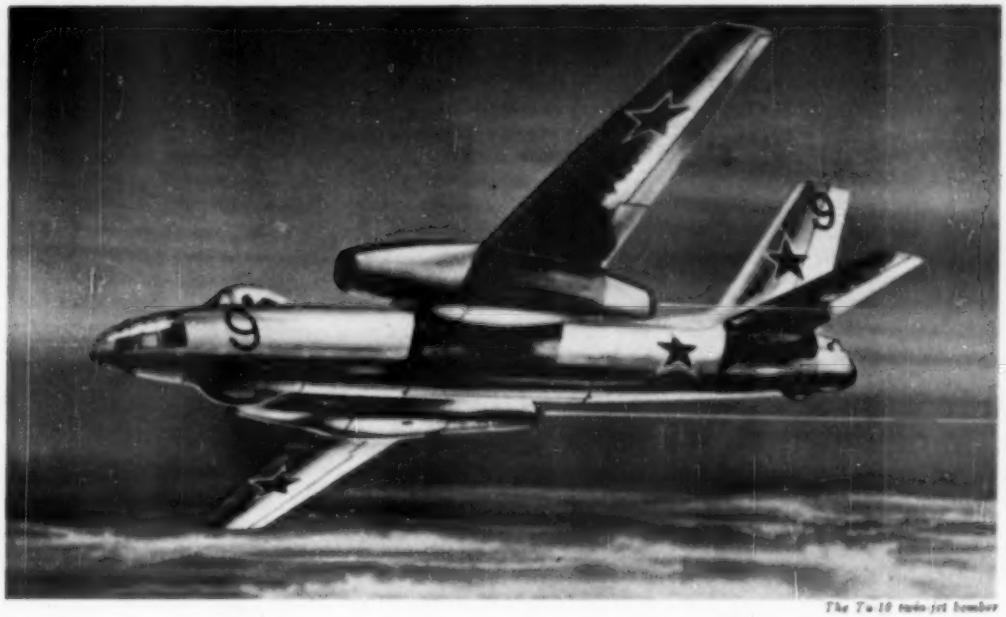
A Department of Defense observer stated clearly the reaction of combat pilots to incendiaries procured by the Corps: "Marine pilots generally agree that napalm bombs are the best antitank weapons they've used. Tanks can be knocked out by a hit anywhere within fifty yards."

Nor can we forget WP (white phosphorus) shells and hand grenades. According to front-line reports, WP still holds its own as an outstanding triple-threat weapon—screening smoke, antipersonnel, and incendiary. It was used effectively to break up tank-led attacks along the Naktong River front, for instance.

Proved in Battle

Unified procurement has also proved its worth in battle. We have supplied the Air Force with napalm and incendiary bombs. As reports indicated, these have done an excellent job against the enemy's strategic industrial targets. Colored smoke grenades and munitions were used for ground-to-air signaling. We have also supplied the Navy with floating oil smoke pots, napalm for the flame throwers extensively used by the Marine Corps, and smoke generators for large-scale screening of ship concentrations, port facilities, and dock installations.

The problem of restoring a peaceful way of life to the people of Korea has not been solved. Therefore the continued cooperation and collaboration of industry and the military are necessary to achieve the goals of the United States in its foreign and military policy: Peace and freedom for all members of the community of nations through cooperative action.



The Tu-10 twin-jet bomber

Russia's Jet Aircraft

An Exclusive Story about the Fast New Soviet Warplanes

William Green and Roy Cross

NO one really knows how far Russian preparedness for action has progressed, but in all past European conflicts Russian war potential has been persistently underestimated. Soviet reticence in divulging the most superficial details of their aviation progress has been interpreted variously. While some argue that quality, if not quantity, is not sufficient for the Reds to wish to boast of their achievements, others consider that latest Soviet combat airplanes are so good that there is every justification for maintaining the tightly meshed security curtain.

Mr. Green, well-known British aviation authority and aeronautical correspondent, and his able collaborator, Mr. Cross, have here prepared what we believe to be the most current and authentic article on Soviet combat airplanes published to date.

The illustrations on these pages cover most of the Russian jet aircraft in service at the present time and include a number of unretouched telephoto films. The recent use of the new MiG-15 Russian fighter by the Chinese Communists in Korea gives added significance to the accompanying information.

—THE EDITORS.

Misleading Attempts

Today, comparison of every new Russian combat airplane with known German wartime projects is in vogue, and many misleading attempts have been made to belittle the capabilities of Soviet airplane designers. Adopted initially by self-styled "authorities on Soviet aviation," these comparisons have created a widespread impression that all postwar Russian military aircraft are the logical development of German design genius.

While impetus undoubtedly was given to Soviet jet research and development by the influx of German equipment, technicians, and scientific documentation during the period 1945-1947, Russian research in the jet-propulsion and high-speed aerodynamics fields is to an equal extent based on work by a number of leading Soviet scientists during the last two decades.

Research Ignored

However, the vital urgency of the war years necessitated concentration on essentials, and the frills and luxuries of long-term tangential research had to be ignored. Major effort was centered on orthodox aviation equipment. Aircraft types were strictly functional, accent being placed on rapid availability and ease of production. These requirements were often obtained at the expense of fullest fighting efficiency, but the Soviet Air Force found that, by weight of numbers, it could bludgeon its rapidly weakening but better-equipped enemy from the sky.

It is not the purpose of this article to review the organization of the Soviet

Air Force or the wide variety of combat airplanes that has been introduced into its ranks during the six years since the end of the war in Europe, but rather to analyze and discuss the very latest Russian combat machines which would, should a third world-wide conflagration break out, form the spearhead of any attack on Western European and United States forces.

First Postwar Jet

The MiG-9 (Fig. 1, p. 290) one of Russia's first postwar jet fighters, appeared in 1946 and is widely used by the Soviet Air Force today for ground-support work and low- and medium-altitude interception. Conforming to the "pod-and-boom" formula—the turbojets underslung in the fuselage nose and exhausting together past the channeled rear fuselage—which was presumably adopted to facilitate engine change and maintenance, the MiG-9 is powered by two M-004 turbojets developed from basic Junkers Jumo designs. With a maximum speed of 520 miles an hour at low altitudes, an armament of one 37-mm. gun and two 20-mm. Sh-VAK guns is carried in the fuselage nose.

Immediately after the war, the Russians used a number of Lavochkin La-9 piston-engined fighters for experimental work with speed boosting, and several machines were fitted with impulse ducts (pulsating athodyds) under each wing while another variant had a liquid-rocket unit in the rear fuselage with the exhaust orifice below the modified rudder. This latter research machine is depicted here (Fig. 5) and, although retouched to bring out important features, this illustration is the best photograph of this experiment yet to be published.

Figure 4 is an authentic, unretouched photograph (taken with the aid of a telephoto lens) of a Tupolev-designed twin-jet attack bomber believed to be designated Tu-8. Derived from the piston-engined Tu-2 bomber, the Tu-8 employs the same wing and tail components as the former but features a redesigned and lengthened fuselage. The lengthy, square-shaped turbojet nacelles are noteworthy features and the wheel-housing bulges can be discerned beneath the jet nacelles. This machine is not believed to have entered service. It was no doubt superseded by the Tu-10 described below.

During May 1947, Russian newspapers and radio news broadcasts reported with a fanfare of trumpets the first successful flights by a Russian research airplane at speeds in excess of Mach unity. As with any news item that emerges from the official Soviet news agency, this claim was viewed with scepticism by the Western press, but when later reports mentioned the appearance of a swept-wing high-speed research airplane in the 1948 May Day air parade over Tushino airfield, many people decided that there must be something in the Russian claim and that this was the sonic flyer.

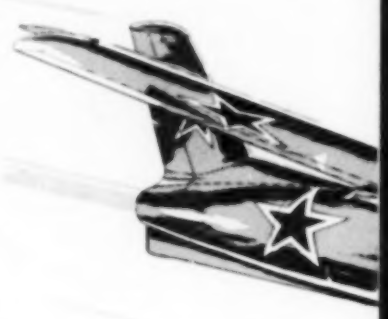
Advanced Research

Although few details of this machine were divulged, the examination of telephoto films underlined the fact that the Russians were immersed in a practical research program as advanced as any then in progress in Britain or even the United States.

The machine they built for this program (Fig. 2), taught Soviet designers much that they wanted to know concerning the practical application of sweepback, but a closer examination of this photoevidence does not support the widespread contention that this machine is a development of the German DFS 8-346 supersonic project, and it is extremely unlikely that this is the airplane with which the Russians passed Mach 1, although it is certain that they did pass it.

Featuring small-span, low aspect ratio wing, and T-positioned tailplane, the concomitant form of the airplane's engine aspiration system looks decidedly subsonic, but the "elephant ear" intake positioning clearly foretells a short direct internal ducting, though ram efficiency at the compressor may leave something to be desired. Difficulties such as the breaking away of the fuselage boundary layer in the expanding duct and disruption of flow caused by the air expanding too quickly around the sharp bends may well have been contributing factors in dictating the use of straight-ram fuselage-nose air intakes in all current Russian fighters.

The wing of the research machine is of comparatively low aspect ratio with sharp leading-edge sweepback and little sweep on the trailing edge. This wing form does not appear to have been successful, for the latest Red fighters favor medium aspect ratio wings with little taper and sharper sweepback.



However, this research machine is obviously capable of very high subsonic speeds, and the Russians were not slow in putting to practical use the experience and know-how provided by its test program, for early in 1949 the first reports of swept-wing fighter aircraft *in service* began to filter through the chinks in the Iron Curtain.

Swept-Wing Fighters

Two distinct types have since been officially identified and are now known to be in quantity production—the MiG-15 (Fig. 7) designed by the Mikoyan-Gurevich team, and the La-17 from a team headed by Semyon A. Lavochkin (see illustration above).

Both these fighters are comparable in functional rôle and general configuration to the North American F-86 Saber, though smaller and lighter.

The two designs differ primarily in the positioning of their forty-degree back-swept wings, the MiG-15 being a full-midwing monoplane whereas the Lavochkin La-17 employs a shoulder-positioned wing. It is on the question of wing, span, and power loadings that the Russian and American schools of thought differ most radically.

Both the Mikoyan-Gurevich and Lavochkin teams have deemed that low wing loading is desirable to permit high accelerations in turns, and low span and power loadings are beneficial both to the rate of turn and the rate of climb. These requirements have been effected in the MiG-15 and La-17, as in wartime fighters, by keeping weight and internal equipment to a minimum and by providing reasonably generous wing areas.

The designers of the F-86 Saber have evidently considered a high limiting Mach number to be a prime requisite, and this has been obtained at the expense of maneuverability at altitude.

The La-17 swept-wing Soviet jet fighter.

Thus, while the appreciably higher wing, span, and power loadings of the F-86 endow it with a higher Mach rating than its Russian contemporaries, the lower loadings of the Soviet aircraft should give them an appreciable advantage in close combat at high altitudes and their superior maneuverability should be especially beneficial when delivering the *coup de grâce* to an enemy bomber.

Good Maneuverability

North American engineers will probably argue, and not without good reason, that generous wing area reduces top speed and structural strength and that the value of a high Mach rating is not to be assessed solely in terms of speed. Implied freedom from compressibility trouble means a steadier gun platform and a happier pilot. Nevertheless, two successive wars have proved that superior maneuverability is frequently of greater value than superior speed. Eyewitness reports state that maneuverability and stability of both the MiG-15 and La-17 are of a very high order.

The Russian fighters employ sweepback on both the vertical and horizontal portions of their empennages. The horizontal surfaces have been lifted to near-T positions and should therefore be free from the rivet-popping propensities that trouble the F-86's tail, due in large measure to the low position of the horizontal unit sitting in the wing wake. The high positioning of the tailplane is apparently beneficial from the standpoint of structural integrity and control efficacy.

Stalling Troubles?

At this point it is of interest to note that Semyon Lavochkin has apparently found his vertical surfaces to be inadequate for full control at high speeds, for the production La-17 features a lengthy fillet which runs along beneath the rear fuselage—possibly dictated by rudder-stalling troubles.

There is evidence that the armament of jet fighters is now undergoing serious consideration and revision. That the F-86 should mount the same armament as the wartime F-47 Thunderbolt seems incongruous, and the Russians have for some time been using combinations of greater potency.

The low-velocity, high-capacity gun, typified by the German 30-mm. Mk-108, has been deemed by some to be superior to the high-velocity weapon of smaller bore, and the Russians are obviously to be numbered among the 30-mm. gun's adherents as their latest fighters all use 30-mm. or 37-mm. weapons with supplementary 20-mm. Sh-VAK cannon.

The latest Russian aircraft guns are believed to follow the principle of the 30-mm. Mauser MG-213, having a higher velocity and a flatter trajectory—the muzzle velocity being about 2,000 feet a second—with rates of fire up to 1,000 rounds a minute. Both the MiG-15 and La-17 carry one such gun in addition to one or two 20-mm. Sh-VAK type. Guns are fitted either side of the nose-wheel housing and, in the case of the MiG-15, protrude somewhat from their troughs.

The power plants of these new fighters are believed to be one of a new series of centrifugal compressor units developed by M. B. Cheloney and A. D. Charomski from the British Rolls-Royce Nene. From the nose ram entry the intakes presumably bifurcate round the cockpit to the plenum (pressure) chamber necessary with the Rolls-Royce twin-sided impeller designs. The Russian-developed Nenes are almost certain to be giving 5,000 pounds' thrust, despite possible lagging in Soviet manufacture of heat-resistant materials and mass-production methods.

During the war, the Soviet fighter pilot's personal equipment was reduced to the barest essentials, as indeed was the plane he flew. The ejector seat is now standard for such types as the MiG-15 and La-17, but G-suits and other "luxuries" are likely to have been ignored and will no doubt continue to be so until they become an absolute necessity for the efficient operation of the plane.

640 Miles an Hour

Indulging ourselves in some possibly rash performance guesses (and presupposing a thrust of some 5,000 pounds) a conservative estimate places the maximum speeds of the MiG-15 and La-17 in the 630-640 mile-an-hour bracket. Their limiting Mach number, however, may be as high as 0.91, though it is unlikely that either machine could reach this figure in level flight until the thrust of the Soviet production turbojets has been boosted to well over the 5,000-pound mark.

However, they should be appreciably faster than the Meteor, Vampire, F-80, and F-84—certainly more maneuverable than the American machines, and easily capable of reaching and fighting B-36 and B-50 formations.

Figure 6 shows Russia's first service jet fighter, the Yak-15, designed by Alex Yakovlev, in formation. Powered by a single M-004 turbojet underslung in the fuselage nose, the Yak-15 can be termed a "lash-up" between the Jumo 004 turbojet and the well-tried Yak-9 fuselage of wartime vintage. Early production models retained the Yak-9's tail-wheel undercarriage but this form has now been superceded on later pro-

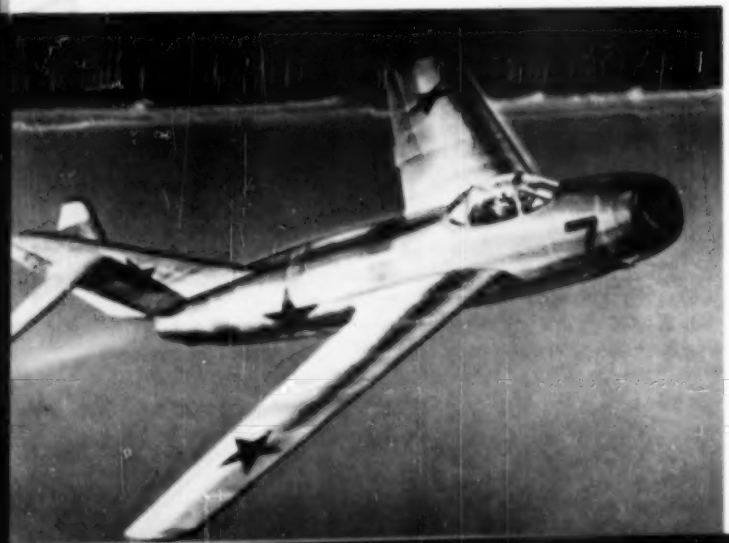
(*Continued on p. 292.*)

Fig. 1. The MiG-9, one of Russia's first postwar service jet fighters, is powered by two M-004 turbojets and carries one 37-mm. gun and two 20-mm. Sh-VAK guns in the nose.

Fig. 2. This advanced transonic research
to have been flying as long ago as 1947 a

Fig. 4. Above, telephoto of the twin-jet attack bomber believed to be the Tu-8.
Fig. 7. The MiG-15, below, is one of the latest and best Soviet fighter planes.

Fig. 5. The Lavochkin La-9, above, is an exp
Fig. 8, below, shows a formation of Tupolev T



ine developed by the Russians is believed
ught much about the swept-back wing design.

Fig. 3. The Ilyushin Il-16 four-jet medium bomber shown in this unretouched photograph has not been reported in service. This airplane is very similar to the German Arado 23

ntal piston-engined fighter with rocket booster.
mbers—the Soviet version of the American B-29.

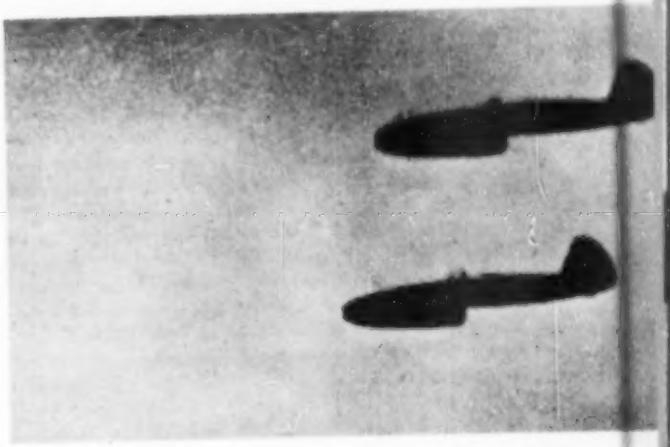
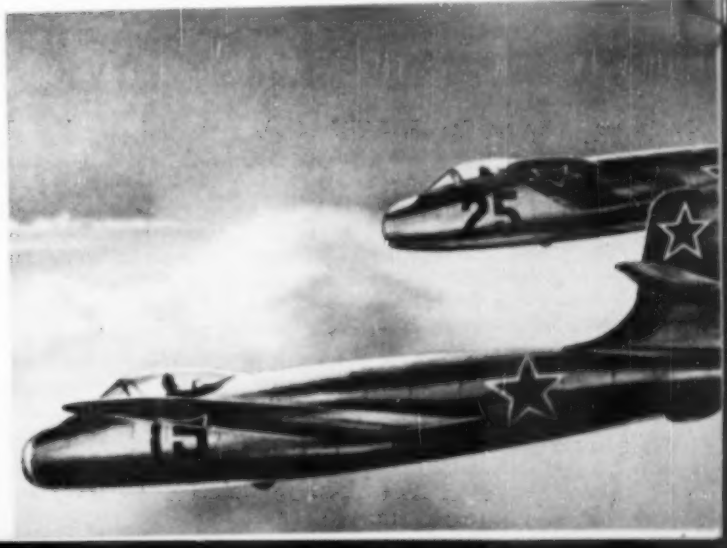


Fig. 6. A formation of Yak-15's, above. Russia's first service jet fighters. Below Fig. 9, the clean Yakovlev-designed interceptor thought to be designated Yak-1



duction models by a nose-wheel unit.

Often referred to as the "Thunderjetovitch" owing to the resemblance it bears the F-84 Thunderjet, this clean Yakovlev-designed interceptor is thought to be designated Yak-17 (Fig. 9). Denoting an intermediate design phase between the early "pod-and-boom" jet fighters and the ultramodern swept-wing designs, the Yak-17 is undoubtedly smaller and lighter than the F-84 and although perhaps its equal in speed and superior in maneuverability, it is unlikely to possess the F-84's radius of action.

The Tu-4 Bomber

A formation of Tupolev Tu-4 bombers, the Soviet production version of the B-29 Superfortress is shown in Figure 8. Quantity manufacture of the B-29 with all its complex remote-control gun-laying and electronic gear will have set the Soviet aircraft industry a unique production problem, and it may be that the Tupolev Tu-4 has been simplified internally and the remote-control defensive system replaced by manually controlled turrets. A considerable force of Tu-4's is now in service with the air branch of the Soviet Navy, recently made responsible for all long-range strategical operations. Although probably inferior to the B-50, it is nevertheless one of the finest bombers in the world. It should be—it was designed in the U.S.A.!

The Ilyushin Il-16 four-jet medium bomber, depicted in the unretouched photograph shown in Figure 3 has not been reported in service. Designed by Sergei Ilyushin, this machine is one of the few Russian jet combat aircraft to which can be traced obvious signs of German inspiration. The many similarities between this machine and the German Arado Ar 234 can hardly be coincidental. The Russian Il-16 is, of course, much larger than the Arado, but the wing position, nose section, and location of the main undercarriage wheels are all pointers toward its ancestry. Possibly Ilyushin employs a number of ex-Arado designers on his staff.

Although the Russians were immediately smitten with the possibilities of wing sweepback for their standard interceptor fighters, evidence shows that they were not taken with swept-back wings for their close-support and light jet bombers, and although there may be an equivalent to the Boeing B-47 on the drawing boards or in prototype form, there is no evidence to show that such a machine is yet in production.

However, it is clear that the bomber spectrum is shifting rapidly to the top right-hand corner of the performance chart, and Russian agreement with this basic fact is to be seen in the fast, modern, tactical twin-jet bomber that is now in quantity production and limited squadron service.

This new machine (see illustration on p. 287) is comparable in many ways to Britain's English Electric Canberra B.Mk.2 (which should start coming into service with the R.A.F. early in 1951) and is believed to have been designed by Andrei N. Tupolev and designated Tu-10. Tupolev's Stalin Prize-winning Tu-2 piston-engined attack bomber will no doubt be remembered by readers as one of Russia's most successful wartime aircraft, and there is little doubt that the Tu-10 is one of this outstanding design's latest progeny.

Any comparison between the Canberra and the Russian machine would, in view of restrictions on data, be somewhat superficial, but the machines are similar in size and functional rôle, and both represent a stage in transition between the fastest piston-engined bombers and the ultramodern swept-wing jet bombers such as the Boeing B-47.

No Sweepback

Sweepback of wing surfaces has apparently been deemed unnecessary at the Mach numbers attainable by the Tu-10 when carrying a useful military load, but here the affinity between the Tu-10 and the Canberra ends.

A circular section obtains throughout the fuselage of the Tu-10, this having been presumably adopted primarily for considerations of cabin pressurization as in the Canberra. However, the clean fuselage lines of the Russian machine are marred by two excrescences other than the cockpit canopy—a bulge under the fuselage nose and a large tail bumper under the rear fuselage.

There is some doubt as to what is contained in the fuselage-nose bulge which may provide accommodation for a backward-retracting nose wheel or, again, may house radar.

The Soviet bomber appears to be a three-seater, the 60-foot fuselage accommodating a bombardier-navigator in a well-glazed nose compartment, a pilot seated ahead of the turbojet nacelles under a 3-piece "blister-style" canopy, and a tail gunner. Whereas the Canberra relies for defense on its speed and exceptional maneuverability, the Russians appear to have been loath to entrust the safety of their airplane solely to its performance, evidenced by the adoption of tail guns. This tail position probably contains one or two 20-mm. Sh-VAK cannon.

Tactical Employment

The Tupolev bomber appears amenable to adaptation for high- or low-level bombing and target marking, but, as there is much evidence to indicate that the Soviet Air Force is still largely subservient to the requirements of the Red Army, it may be assumed that this aircraft's primary rôle will be that of close-support, low-level cooperation with armored columns.

It may therefore also be assumed that this airplane will carry a heavy forward-firing armament of 20-mm. and 30-mm. guns for ground strafing. Further, in the light of the recent appearance of a version of the Tu-2 carrying a heavy 53-mm. tank-busting cannon offset in a redesigned nose, it is to be expected that a Tu-10 carrying a large-caliber-shell gun will eventually appear.

Western military authorities are obviously disturbed by the knowledge of these new Russian combat machines. Their appearance serves to illustrate lucidly the gap-bridging process that has been carried out in the Soviet Union during the last few years in making up the leeway in technical progress so long held by Britain and the U.S.A. The Soviet Air Force, already superior to the combined air arms of the Atlantic Pact signatories in quantity, is now approaching parity in the qualitative sense.

The Time Gap

Industry Must Prepare at Once for Its Defense Rôle

Roger F. Waindle

INTERNATIONAL economists talk much of the importance of the "dollar gap" in export-import matters. However, the life of America—which well may mean the life of the free world today—may depend upon what we do about the "time gap" in industrial preparedness.

Most of us are aware of the time gap between M-Day and the day American arms became effective in the last two wars. Most of us are also aware that American industry contributed to the winning of World War I and was indispensable to the winning of World War II. What most of us like to view ostrichwise is what will happen the next time when an aggressor has studied thoroughly the decisive factor of American industrial production in past wars *after* it finally was cranked up, put in gear, and gotten under way. In short, the next world aggressor won't let American industry spend months or years shifting its economy and retooling for war.

The problem, therefore, is to convert right now from a "peace-loving nation" to a "preparedness-loving nation." Since it is generally recognized that we are not a military nation, the next best thing is that American industry will condition itself to a better position of preparedness and maintain that position indefinitely "just in case"!

The Problem

Here, briefly, is the problem: Our potential enemy is known to have currently ten to twenty times the weapon stock pile that we possess. However, when hostilities begin, it is difficult to engage an enemy on a large scale immediately. Hence, our meager supplies might permit an adequate short-time defense. As protracted enemy engagements multiply, the rate of weapon attrition increases rapidly, particularly if initial retreats or "holding engagements" are necessary because of the initial attack advantages of the aggressor.

Industrial Conversion

This is where the time gap becomes important. Industrial production must convert to, and accelerate, military production so rapidly that, before the aggressor can obtain a decisive position, our military might can be assembled at a rate that will provide a roll-back of his initial advantage.

While our potential enemy is considered to have a definite superiority in initial weapons' availability, the production potential of our country is estimated to be about four times greater. Therefore the important problem is to get the sum of our weapons stock pile, plus converted industrial production, to exceed that of the aggressor before the war becomes critical.

The industrial-preparedness condition of the country today leaves much to be desired. Findings of the National Industrial Conference Board in a survey begun in mid-1949 and published in July 1950 brought out the following:

(1) Of 150 companies surveyed, only 19 had formulated any definite plans for mobilization; (2) Half the 131 non-planners felt mobilization plans were unnecessary; (3) Many executives cited lack of specific Washington direction as reason for the small amount of planning done.

Since the outbreak of the Korean war, industry has alerted itself to more interest in the subject of preparedness. The National Security Act of 1947 created the Munitions Board as an agency of the national military establishment under the Secretary of Defense with responsibility for national mobilization planning.

Therefore, under the Munitions Board there is a most highly developed industrial-preparedness activity under the title, "Allocation of Private Industrial Capacity for Procurement Planning of the Armed Services." This activity has resulted in the Industrial Mobilization Plan under which is seen one of the first apparent benefits of unification.

Requirements Pooled

Instead of all the services and various allied agencies descending upon an industrial firm seeking planned output, the services are required to pool their requirements through the Munitions Board. This Board, in turn, assists the industrialist in selecting one service with which that industrialist will have all his mobilization-planning contact regardless of the number of services for which he may manufacture military items.

The chosen service is designated as the ASPPO (Armed Service Procurement Planning Office) for that company and the ASPPO then works out plans with the company for consideration by the Munitions Board. The company may be a planned source of essential products for one or many services, but its planning is accom-

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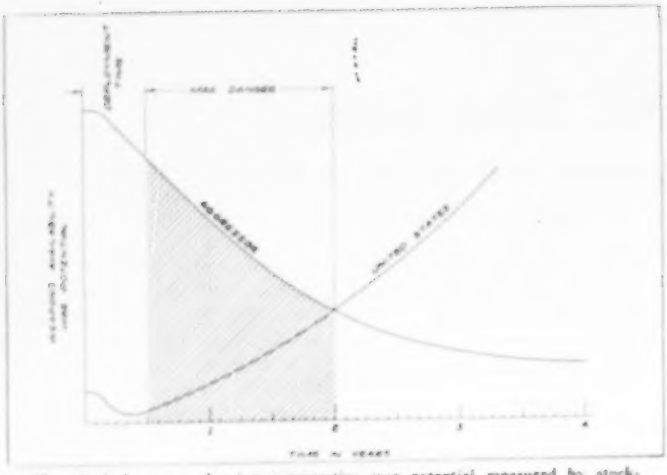

Hypothetical curves showing comparative war potential measured by stockpile production, corrected for attrition. At the point of intersection, the war is won by the United States. The problem is to shorten the time element or steepen the production curve so that the lines intersect quickly.

plished with only one service, its ASPPO.

It must be emphasized that mobilization commitments are voluntarily made by the company, rather than the military, and can be changed at any time by the company.

Mobilization plans should do much to reduce the time gap, but they have several weaknesses:

First, flexibility. Mobilization plans should be flexible enough to reflect all technical changes in types and choice of weapons and should even anticipate where a future war is to be fought. It is obvious that much different equipment would be required to fight a polar war than one on the equator. Again, for example, if initial war experience would indicate the aggressor possessed a completely successful means of jamming our proximity fuze, larger quantities of mechanical time fuzes would be required than had been planned. What would happen to the many companies which had planned to make VT fuzes? Would they be left idle because there were no mobilization plans for them under changed requirements?

Plans Too Rigid?

In known instances the armed services have forbidden their procurement departments to solicit bids from other than those companies set up in the mobilization plans to make the particular item being procured. Is not this likely to lead to the rigid planned production of the Nazis? German planned production worked all right initially but was not sufficiently fluid to keep pace with the changing logistics required to meet the moves of the enemy. There is a fear in many minds that our mobilization planning is not sufficiently fluid.

A second apparent weakness in mobilization planning as presently executed lies in the fact that it can only reach the larger companies.

The Best Plan

While present mobilization planning is admitted to have possible defects such as listed above, it is still, in the opinion of those who have studied it, the best plan conceivable today. And, fortunately, there are several rather simple steps that can be taken to offset the deficiencies of the master plan.

The most important of these is manpower. Regardless of the size of a company—whether it employs one or one hundred thousand—it is guided by men! If we educate a sufficiently large segment of our production men—if we interest them and keep them interested in military production—we can overcome much of the inflexibility of our master plan—the M-Day plan.

These production-management men and engineers will also come largely from the ninety per cent of our important American military production potential not now reached by mobilization plans.

A.O.A. Committees

The many Technical Committee members of the American Ordnance Association are "keeping their hand in." However, an analysis of Committee membership indicates that too few companies are represented there.

The Army Ordnance districts maintain regular monthly educational activities for their Reserve officers. The local Posts of the A.O.A. can easily do the same for their vast membership of "industry reserve" by bringing instructive, interesting speakers before their membership in monthly meetings and by supplying releases for daily newspapers, periodicals, and house organs.

A proposal has been made to provide tax adjustments for companies in direct proportion to the time and money spent on approved industrial-preparedness activities. This could be the basis for a real long-time continuous effort.

Let us remember that time is on the side of the potential aggressor. He lacks production ability equivalent to our potential, but he more realistically plans to build his weapons' stock pile even further. When it is the right time for him to strike, he hopes to overwhelm us so fast by force of arms and internal sabotage that we just won't get our industrial machine turned around fast enough from peacetime manufacture to stop him. In other words, the time gap may beat us the next time unless we can become a preparedness-loving nation now.

Industrial preparedness must become a hobby. Just as each Swiss male is kept trained for the army—just as each Swiss cupboard contains the rifles for the men of that family—so we here in a country of unprecedented industrial might must keep ourselves conditioned to military production. Let's make a hobby of preparedness.

We might borrow the safety slogan: "Remember, the life you save may be your own!"

Newer Weapons To Keep Pace with the Newer Targets

by

Comdr. L. G. Pooler

"The projectiles will be new, the guns will be new, and the projectile velocities, if we succeed, will be double that of our present weapons"

HISTORICALLY, ordnance engineers and ballisticians have endeavored to develop equipment capable of launching missiles with sufficient velocity to overtake a target and effect its destruction. The devices invented are legion, and they have grown in complexity through the centuries from the bow and arrow to the modern naval rifle with its intricate fire-control mechanism. Since the discovery of gunpowder, the gunner has had a distinct speed advantage over the quarry—until recently.

Revolutionary Change

In the past, the speed of the quarry has never been of too much concern to the gunner. Man moved slowly and could be easily overtaken. Today, however, a revolutionary change is taking place through developments in the field of aviation. The gunner's speed advantage has decreased almost to the vanishing point. An F-86 Saber flying at 880 feet a second is an impossible target in an overtaking shot for a man on the ground armed with a caliber .45 automatic pistol which has a muzzle velocity of 800 feet a second. Even a fast-thinking antiaircraft gunner with one of the best modern guns and lead computing sights has lost much of his previous advantage.

The relation of missile to aircraft speed is shown graphically in Fig. 1. Note, however, that the speed scales on the two sides of the center line are not the same.

Today we are confronted with a formidable problem. There is every reason to anticipate that soon combat aircraft will be flying at supersonic velocities. That mysterious barrier, the speed of sound, has not proved to be insuperable in the speed of flight, notwithstanding the predictions of many of the experts of two decades ago.

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Predictions Fell Short

In 1945, many predictions and estimates of future progress were made by the country's foremost aeronautical engineers which fell considerably short of present achievements. The reason for these underestimates can now be traced to two causes: first, few aerodynamicists in this country were aware of the potentialities of the swept-back wing which was developed in Germany during the war, and, secondly, the jet engine as a reliable means for propulsion has greatly exceeded the most optimistic predictions.

Turning now to progress in ordnance during this same period, what has been accomplished? Measured in terms of progress since the turn of the century, the accomplishments by the Navy's Bureau of Ordnance have been considerable: higher rates of fire for larger caliber guns, better gun steels and liners with greater resistance to erosion, better propellants having greater stability and more uniform burning rates, and range tables computed to an additional significant figure.

On the other hand, the increase in projectile velocity has been negligible. The projectile muzzle velocities of modern service guns in nearly all calibers

now fall in the range from 2,700 to 3,300 feet a second—up only 10 per cent from pre-World War II—while in the same interval antiaircraft-target velocities have increased 300 per cent.

Every means for increasing the velocity of spin-stabilized projectiles has been exhaustively studied, and, if the goal is to be a 100 per cent increase over present velocities, its achievement with the conventional type of gun now appears to be doubtful. Increased velocity requires increased powder pressure which is seriously limited by our inability to increase significantly the yield strength of even the best alloy steels. Squeeze-bore guns are a possibility, but their short barrel life raises a serious objection.

To attain our goal a radically new approach is required, new principles must be discovered and explored, and new designs employing these principles developed. Fortunately, tools are now available for the basic research, such as wind tunnels which can attain a Mach number above six, and pressurized shooting ranges. With such tools, systematic studies of drag coefficients, projectile stability, boundary-layer configurations, and heat-transfer investigations are feasible.

New Data Obtained

New thermodynamic data have been obtained on the behavior of gases over the wide range of pressure and temperature, particularly under extreme conditions, which will be of great value in gun design. Meteors and shaped charges have also been studied to obtain information on the drag forces which act on irregular particles traveling at velocities in the Mach-number range from twenty to thirty. The proper path to be followed is gradually becoming dimly discernible, but much work remains.

The first requirement is to design a projectile having a low drag which will be stable in flight. Here history repeats, for many centuries ago man developed such a projectile—the arrow, a fin-stabilized projectile with a high fineness ratio (ratio of length to diameter), a configuration which is characterized by low drag and is very stable in flight.

In this country during the last war considerable study was given to this configuration in connection with the design of aircraft rockets. It is a configuration which is only stable at high velocities when the air flow over the

fins is sufficient to produce the necessary lateral forces for stabilization. Fortunately, such conditions exist when rockets are launched from high-speed aircraft. Here, owing to the velocity of the plane through the air, the rocket fins are effective in holding the projectile on its course during the early stages of burning. Considering that modern military rocket development did not begin until 1943, progress has certainly been very rapid.

This country was not alone in the development of aircraft rockets. The Germans had an excellent aircraft rocket and, in addition, had conducted test firings of fin-stabilized projectiles from smoothbore guns using a sabot to confine the powder gases. It was found that very high velocities could be obtained without excessive powder pressures and that the projectiles had very small dispersion and surprising range (sixty miles).

But the most amazing observation was that after fifty rounds had been fired a star gaging of the bore showed not only that there had been no appreciable erosion but that some metal had been added to the bore from the sabots. Fortunately, the war ended before an operational projectile of this type and a gun to shoot it could be developed by the enemy.

Investigations Extended

Once the above information had become available, it is not surprising that the Navy's Bureau of Ordnance decided to extend the German investigations of fin-stabilized projectiles. Firings recently have been conducted in the pressurized range, a steel tube 320 feet long and 3 feet in diameter, at the Naval Ordnance Laboratory, White Oak, Md.

Within this tube are photographic stations where the projectile takes a spark photograph of itself in passing. Such a photograph of a fin-stabilized projectile in flight, traveling with a velocity of 4,000 feet a second, is shown in Fig. 2.

A study of Fig. 2 reveals interesting information. The narrow wake indicates a high base pressure and low drag. The sharp angle of the Mach cone, shown in cross section by the shock wave from the nose, is a measure of the velocity, and the character and thickness of the boundary layer can also be estimated.

An accurate determination of the drag coefficient requires more elaborate techniques. The spacing between photographic stations is known to

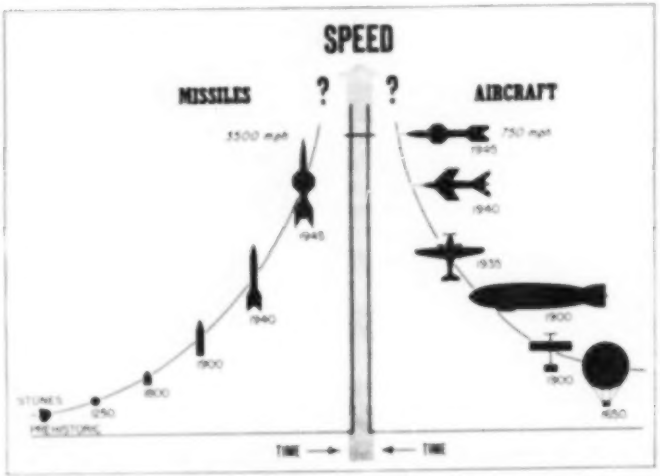

Fig. 1. The relation of missile speed to aircraft speed through the years.

0.001-inch which includes a correction for earth curvature.

To insure constant temperature conditions the range is air-conditioned the year round and the temperature held at 70 degrees Fahrenheit plus or minus one degree. Time intervals are measured by an electronic counter to a precision of one tenth of a microsecond. From data taken at successive stations the drag coefficient is computed on an automatic high-speed electronic calculator.

Reynold's Number

Scale effects always present a problem which is equally important in range tests as in wind tunnels if the free flight performance of a missile is to be obtained. For complete similarity, tests must be conducted at the same Reynold's number. Reynold's number, generally denoted by R, is defined by the relation $R = \frac{v L \rho}{\mu}$ where v is the missile velocity, L a dimensional length, ρ the density of the air and μ the coefficient of viscosity of the air.

For a given test, v will be specified, and μ cannot be changed appreciably. Suppose we are testing a one-fifth scale model, then, if fired in the open, ρ will be at atmospheric pressure and the Reynold's number will be as one is to five for model and missile. But now the value of the pressurized range becomes evident. Suppose we raise the pressure in the range in which the model is to be fired to five atmospheres, then the Reynold's number of model and missile will be the same, and all aeroballistic quantities measured in the range will be identical with those which would be measured in free flight if it were possible to make such measurements. From the above it is seen that, in connection with missile-design studies, a pressurized range is a unique tool of great value in which Reynold's numbers can be varied from 50,000 to 50,000,000.

In connection with the development of projectiles, supersonic wind tunnels can also render very useful service. Modern tunnels are of two main types: the continuous tunnel, in which the air is circulated around a closed circuit by means of a large blower, and the intermittent tunnel. In the latter, air, generally at atmospheric pressure, is drawn through a drier to remove moisture, through a Laval nozzle to raise the velocity to supersonic, then through a diffuser to regain some of the lost pressure. Finally, the air is drawn into an evacuated vessel of large dimensions.

Fig. 2. Fin-stabilized projectile traveling 4,000 feet a second.

Intermittent tunnels are generally designed to have a blowing time of anywhere from twenty to forty seconds during which the velocity of the air in the test section remains constant. In general, this is ample for taking measurements which frequently require only four or five seconds after the steady state has been attained. The type of measurements usually made involve such quantities as lift coefficients, pitching moments and boundary layer, and heat-transfer studies. A typical wind-tunnel photograph of a missile taken with a schlieren camera is shown in the photograph on page 295.

Complicated missiles frequently require extensive test programs before specified performance and optimum design are achieved. The study of base pressures so important in projectile design can be most effectively conducted through wind-tunnel tests.

Since in wind tunnels, as in ranges, scale models are used, Reynold's number has an important effect which can only be overcome by building large tunnels with large test sections. Such tunnels, however, soon become very costly and require enormous quantities of power, particularly if they are to be of the continuous type. Reliable results can frequently be obtained in smaller tunnels, but occasionally checks with free-flight tests are necessary. For this purpose a pressurized ballistic range serves as a valuable adjunct.

Returning now to our main problem, the development of a very high velocity projectile requires investigation over the Mach-number range from five to ten. A small tunnel ($4\frac{1}{2}$ by $4\frac{1}{2}$ inches) for this purpose has been constructed at the Naval Ordnance Laboratory, and recently a Mach number of 9.25 was obtained. Air at 6 atmospheres was allowed to expand through a nozzle into a sphere of 2,000 cubic meters' capacity which had been almost completely evacuated. An expansion ratio of 7,000 resulted and an indicated Mach number of 10.

"Hyperballistics"

Undoubtedly, many major problems will have to be solved before a systematic study of this region can be completed, but the preliminary work is now well underway, and the instrumentation and tools are being developed. The name "hyperballistics" has been given to these studies to distinguish them from the region up to Mach number 5 which for long has been the accepted range of our knowledge of ballistics.

Where these studies will lead and how the final end product will function is impossible to predict. The task may prove simple or it may prove to be very formidable. Undoubtedly there are many shoals in those uncharted regions which we are about to explore, but we have developed new instruments for their detection and are well embarked on the most unconventional adventure in the field of ballistics in nearly a century. The projectiles will be new, the guns will be new, and projectile velocities, if we succeed, will be double that of our present weapons.

Contract Cost Principles

Section XV of the Armed Services Procurement Regulation

by

Brig. Gen. T. R. Rampy

Auditor General
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The Contract Cost Principles are intended as a statement of concepts and interpretations which would be reasonably applicable to the large majority of contracts and would result in equitable transactions between the Government and industry

IN order to administer cost-reimbursement-type contracts with a minimum of discussion and misunderstanding as to the types and amounts of costs allowable, the Defense Department has provided the Contract Cost Principles as set forth in Section XV of the Armed Services Procurement Regulation.

Balance Sought

These principles were developed as the result of cooperation among the three services—Army, Navy, and Air Force—and after discussions with representatives of industry. They represent an expression of policy based on experiences and mistakes of the last war with a view to avoiding ambiguity and uncertainties in dealings with contractors and are directed toward maintaining a suitable balance between the protection of the interest of the Government and fairness to contractors.

The principles are intended as a statement of concepts and interpretations which would be reasonably applicable to the large majority of contracts and would result in equitable transactions between the Government and industry.

No contract is satisfactory, however, which does not provide for a fair profit, but again the word "profit" must be interpreted. It is not always measured in terms of dollars related to a particular contract. It may be "profitable" to take a particular contract where there is no "profit" in the form of cash income directly attributable to it.

In considering the allowability of costs, it is well to recognize that the Government has a concept of cost which is different from that ordinarily accepted in business. Although the general opinion is that the Government is strict in its definitions of cost, examples have been noted where the terms of contracts of cost type between private industrial concerns were more restrictive.

It will be recalled that during the past war a large volume of War Department procurement, especially in the Air Force and in the Navy, was placed under cost-plus-a-fixed-fee contracts which used a definition of cost commonly referred to as TD-5000 (Treasury Decision 5000). Actually this definition was only a portion of TD-5000 and was selected because it was convenient and came to the attention of procurement officers due to its use by the Bureau of Internal Revenue in the administration of the provisions of the Vinson-Trammel Act, Public Law 671, Seventy-sixth Congress.

A slight modification of this definition of cost was issued in a pamphlet known as the "Green Book" which was widely used in Navy contracts but was not placed in Air Force contracts. This naturally led to confusion in contract administration. The present contract cost principles are, therefore, now used in place of the above-described definitions in accordance with the provisions of the principles themselves.

> "No contract is satisfactory which does not provide for a fair profit, but again the word 'profit' must be interpreted. It is not always measured in terms of dollars related to a particular contract. It may be 'profitable' to take a particular contract where there is no 'profit' in the form of cash income directly attributable to it."

Uniformity Considered

It was recognized in the development of the principles that a manufacturer treats practically every expenditure as a determinant of total cost. However, the necessity for uniformity in order to avoid possible claims of unfair or inequitable treatment of one contractor when compared with another was an important consideration.

It would be undesirable, particularly under cost-reimbursement-type contracts, to leave the determination of cost as a responsibility of contracting officers and auditors without a guide as to what other contracting officers and auditors consider a cost of similar contracts.

Therefore certain arbitrary decisions had to be made, and, as in the case of any such arbitrary action, not every one is pleased. It was intended to provide sufficient flexibility to avoid inequity in any particular case.

It is recommended that all individuals in industry who are concerned with cost-reimbursement-type contracts of the Defense Department carefully study the principles prior to entering into final contracts which include these principles. It will be noted that the principles give the effective date for use as, "on and after March 1, 1949," and that they are applicable to cost-reimbursement-type contracts and cost-reimbursement subcontracts thereunder (Paragraph 15-101).

In order for the principles to be effective in any particular contract they must either be set forth in the contract or specifically incorporated therein by reference. The principles are divided into parts according to types of contracts. Part 2 covers supply and research contracts with commercial organizations and gives the general basis for determination of costs. Paragraph 15-201 is very important and is considered to give an over-all idea of the intent of the Defense Department with respect to accounting.

"Every effort is being made by the Department of Defense to reduce the number of accountants who are required for the examination of contractors' records, but the extent to which this can be done depends to a major degree on the quality of the contractors' accounting systems.

"As the Nation is now embarked on a program of improving its defenses, unprecedented amounts of money will be needed. The accounting organizations of the armed services and the accounting staffs of the contractors must cooperate to the greatest extent possible in simplifying their mutual problems, thereby doing their part to get the greatest military strength possible from the appropriations made available."

Allowable Costs

Part 2 also includes a description of allowable direct and indirect costs and certain examples of items of unallowable costs. It should be noted that Paragraph 15-204 states that these are examples of items of unallowable costs whether treated directly or indirectly by the contractor. Careful consideration was given to each of the items listed as unallowable, and it is well known that no two individuals are likely to agree that each of the eighteen items listed is proper for exclusion from total cost. However the transmission has been made, and it is being generally accepted by industry. It was not intended to imply that the principles could not be amended if it is found that they are inequitable. The Defense Department will consider amendments as necessary.

There is one item in particular in the listing which might be generally considered to have been incorrectly stated. That is item (d), commissions and bonuses (under whatever name) in connection with negotiating for a Government contract.

Although it is not illegal to disallow such commissions and bonuses by means of a contractual agreement, the Armed Services Procurement Act of 1947, Section 4A, does not specifically disallow amounts payable to "bona fide employees or bona fide established selling agencies maintained by the contractor for the purpose of securing business. . ." It is believed, therefore, that amendment or clarification of the principles will be necessary.

Interest on borrowings listed as unallowable, item (k) in this paragraph, is another one of the very controversial items. One reason for disallowing this type of expense was an effort to place contractors on a more nearly equal basis. In other words, a contractor who has his own working capital would appear to be discriminated against if another contractor who had to borrow his working capital and pay interest on it were allowed to recover the interest as a contract cost.

It would be possible, of course, to compensate for this difference in contractor qualification by adjustment of the rate of profit. This was considered, but, in order to develop more uniform administration on account of the relatively small amount of money involved, it was decided that it would be simpler to disallow all interest on borrowings.

Certain other complexities could arise in connection with interest since the purpose for borrowings could not always be clearly discerned. Some contractors might obtain funds through bond issues, others through stock issues, and still others through straight bank loans. The question would then arise as to whether the interest involved was reasonably allowable to the contract.

Part 3 deals with research contracts with nonprofit institutions and includes sections concerning allowable and unallowable costs. It should be noted that this part is intended to be a paraphrasing of the principles contained in the "Blue Book"—"Explanation of Principles for Determination of Costs under Government Research and Development Contracts with Educational Institutions."

Part 4, covering construction contracts, differs in large measure from Parts 2 and 3. It is based on the premise that construction work is usually performed as a separate and distinct project indirectly associated with or related to other activities of the contractor. On this basis, cost items of an indirect nature are generally very limited and can be fairly well isolated.

This being true, it is relatively simple to determine the actual cost of a particular project and the indirect expenses which may be applicable to it.

Part 5, suggestions affecting cost which may require special consideration, is a very important part of the Contract Cost Principles. The contractor and the contracting officer are here put on notice that it is desirable to consider these as well as any other items which may arise in the course of performance of a contract, which, if not clearly explained or covered by some agreement, might result in misunderstanding. The suggestions listed in Paragraph 15-202 are examples only and are based on those things which have in the past resulted in confusion due to lack of clear understanding between the contractor and the Government.

Accounting Systems

In considering this over-all subject of procurement, particularly negotiation of prices of both cost-type and fixed-price-type contracts, industry should give consideration to the development of adequate accounting systems. The Defense Department does not intend to prescribe specific accounting methods or procedures for contractors. In the first place it would be a practical impossibility, and in the second place it is well known that industry has the ability to develop its own accounting systems which will properly and adequately reflect costs.

Rockets Today

The Military Potentialities of Jet Propulsion

Maj. James R. Randolph

Major Randolph is a mathematician of note and has long experience as a teacher in several of the outstanding engineering schools of the country. He was a member of the Ordnance Reserve Corps during World War II and for many years has been a student of the possibilities of the military employment of rockets.

PRIOR to the Second World War American service journals predicted the type of armored warfare we now call "blitzkrieg." A few American officers who had ideas of what rockets could do set to work to devise ways in which fast tanks could be stopped and the enemy overcome without the prolonged stalemates of World War I.

Among the ideas suggested and developed were "a shoulder arm that can stop a tank" (now known as the bazooka), the use of rockets to provide large-caliber recoilless artillery for airplanes, and the use of huge numbers of rockets to smash an enemy's position all at once and let the infantry go in before the enemy had time to bring up reinforcements.

The Pay-Off

The prewar work of these few officers paid off at Kasserine Pass where Rommel's armor was stopped with the aid of bazookas. It paid off in the Normandy landings where the terrific massed fire of rocket ships helped to establish the beachhead before the Germans knew where it was to be. It paid off in Korea where the larger bazooka and the large rockets now carried by planes proved able to stop the fine Russian-made tanks. And it has paid off more recently in Europe where a conference of Soviet high brass decided that their forty thousand tanks could not be used as planned because of the damage American rockets could do to them.

If the Red Army attacks Europe at all, its advance will be closer to the speed of the Kaiser's foot sloggers of 1914 than to the speed of Hitler's tanks in 1940, thanks largely to rockets.

Another application of rockets which also came in early was the jet-assisted take-off of airplanes (JATO). The power required to get a loaded airplane up to flying speed on the ground is much greater than the power required to keep the plane flying when it is in the air. But this extra power is needed only for a very short time. Hence a light and cheap unit is better than a more efficient unit which costs and weighs a whole lot more.

Powder-burning rockets were used in the first experiments with JATO. They have the same advantages of cheapness and convenience that they have in artillery uses. And they have the same disadvantages of low efficiency and excessive weight. They have an additional disadvantage in that the metal case is so heavy that it has to be dropped when the plane is airborne and cannot usually be recovered in shape to be used again.

The simplicity and ease of handling of the powder-burning rocket are less important with JATO, since planes using JATO usually take off from bases where elaborate installations can be maintained. Hence there has been considerable experimentation with liquid-fueled rockets for this use.

Liquid fuels involve complex handling problems. But they give a lot more thrust per pound of rocket, and they make it possible to build the JATO rockets into the plane where they can be reloaded and used again and again. A plane needs its JATO only where it has refueled before take-off. At a stop where no fuel or extra cargo is taken the plane has generally been lightened enough by using up a part of its fuel so that it can take off with engines alone.

Several propellent combinations are now being tried for JATO's. For this job it is less important to get the highest possible jet velocity than to get a combination that is certain in operation, easy to store and handle, and not poisonous or too expensive.

The present state of the art is reminiscent of the early days of the automobile industry when steam and electric automobiles were still competing with gasoline. The solution will be along similar lines, with standardization of all JATO's for the propellant which proves the best in the most ways.

As the performance of bombers improved, officers watching antiaircraft artillery in action became more and more discouraged by the length of time it takes a shell to get "upstairs" and by the things an enemy plane could do in that time. Moreover, the increase in bomber range has greatly increased the area needing to be defended and has made more and more objectionable the cost and weight of antiaircraft guns.

The Guided Missile

The guided missile has grown out of this kind of thinking. It is a rocket or a ram jet which can take off from a light and cheap ground installation and then can be guided to an enemy plane by radio or can "home" on it because of the plane's hot exhaust, its metal construction, or its effect on light or radar. Guided missiles can protect a whole state about as cheaply as guns can protect one city. They are less wasteful and are more effective.

Guiding mechanisms have involved a tremendous amount of development work. A 400-page textbook is needed to explain their mathematics alone.

But guided missiles are not the only market for all this costly apparatus. Similar equipment enables airplanes to take off, fly across the ocean, and land without the touch of a human hand on their controls.

It will permit rocket mail to cross the continent in an hour and land safely near the postoffice at the receiving end. It permits huge machines to form the most complicated shapes, such as propeller blades, by following automatically the curves on a wooden template.

A guided missile needs the highest possible speed, and this requirement dictates the choice of propellants. Smokeless powder is out, in spite of its convenience. Propellants usable for JATO's may be out because of the low jet velocity they permit. Only the most efficient fuel combinations, giving the highest jet velocities, can be used.

The Ram Jet

The ram jet is a formidable rival to the rocket in this field. It has the advantage of being able to take its oxygen from the air, whereas the rocket must carry its oxygen along. The products of combustion of either are mostly water and carbon dioxide. Water is eight-ninths oxygen by weight, and carbon dioxide nine-elevenths, so that big savings in weight are secured by taking the oxygen from the air.

This is possible for missiles with speeds higher than the speed of sound, for at such high speeds the ram of air into an opening in the front gives it sufficient pressure to operate the nozzle without the compressor and turbine characteristic of jet planes operating at lower speeds.

In addition to the guided missiles fired from the ground against airplanes there are also guided missiles designed to be fired from a fighter plane against a bomber and missiles designed to be fired from a plane at special targets on the ground. Ability of the plane to guide the missile by radio, or ability of the missile to "home" on some metallic object or on a radio station, greatly increases the range from which the attack can be made and makes the plane safer from enemy fire.

Peacetime rocket development in the United States has chiefly aimed at exploration of the upper air beyond the reach of balloons. Dr. Goddard built the first of the modern high-altitude rockets in 1937. Recent American rockets have gone to altitudes of 250 miles and have taken photographs from out in space. Plans are now being developed for putting a rocket into a satellite orbit where it can circle the earth indefinitely as a little man-made moon.

This first "star wagon" will probably be an unmanned rocket carrying instruments and transmitting their readings by radio. Later, manned rockets will be shot out in parts and assembled in space, and from that point to real space travel is just a question of time and money and interest.

The Germans copied Dr. Goddard's 1937 rocket, with a few improvements. They made it in larger sizes, gave it a war head of TNT, and used it as the familiar V-2 rocket for the long-range bombardment of enemy cities. At the time of their defeat they had on their drawing boards a much larger multiple-step rocket capable of bombarding New York City from France. The Russians are now improving on this design.

Americans, in developing long-range rockets for war, would want to aim at targets of military importance, such as the Kremlin, where all authority in Russia is concentrated, important factories whose locations are known, or the railroad junctions, which are still very important in Russia due to the poor road net.

It is because of our interest in such pin-point targets that Americans have developed control mechanisms ahead of rockets and will keep their long-range rockets under wraps and off production lines until they are really good.

When America reveals a timely improvement on the V-2 it will be as surprising, and as decisive, as the atom bomb which burst over Hiroshima.

Rocket research is now one of the big industries of America. More than *e* hundred million dollars are being spent on it every year. The Defense Department and numerous private corporations are working closely together and are producing some highly interesting results, most of which are being kept from the general public.

Guided missiles, and other rockets which travel in air at supersonic speed, have joined with supersonic plane designers in stimulating interest in the behavior of air and of bodies moving through the air at these high speeds. The problem is entirely different from that of airplanes at slower speeds and has opened up a whole new field of studies. Supersonic textbooks are just beginning to come out. There are only a few supersonic wind tunnels.

Test Ranges

For flight tests of modern rockets it is necessary to have ranges of fantastic size over which rockets can be fired without hitting anything of importance while preferably coming down on land where the point of fall will be marked. Russians fire test rockets across the Baltic into Sweden. Civilized nations are on the lookout for huge stretches of uninhabited land.

The best of all these is the British Long Range Weapons Range in Australia. Its headquarters and firing line are at Woomera, near Adelaide. From there it stretches northwest 1,200 miles across the desert to the Indian Ocean, and then there is a possible overwater range of an additional 1,500 miles to Christmas Island. A rocket able to go that far without wings could go to Moscow with them—on the same course.

America has not been able to find a test range even approaching that length. But Americans do not anticipate a situation in which they will not be welcome at Woomera.

Rockets today are being used with good results for jet-assisted take-off of airplanes, for propelling guided missiles, and in supersonic and upper-atmosphere research. Long-range homing missiles may follow.

Logistics and Strategy

Planning for Both Must Be Integrated and Concurrent

by

Vice Adm. F. S. Low

"Strategic plans for future warfare will not be able to contemplate any major operations during the first eighteen to twenty-four months of an emergency unless the necessary supplies are on hand at the start, or the production cycle is well started"

STRATEGY provides the scheme for the conduct of military operations; logistics provides the means for carrying out the strategic scheme.

The close relationship between strategy and logistics can be illustrated from the Second World War.

Rather elaborate strategical and tactical plans existed for the defense of Bataan in the Philippines, but when war came the defenders were forced to fight on short rations, with critical shortages in ammunition, and with no large reserve of necessary tropical medicine. I feel certain that by March 1, 1942, every officer, enlisted man, and civilian on Bataan was logistics-conscious.

Guadalcanal

Another example is reflected in the early days of the South Pacific campaign. Our capture of Japanese-held Guadalcanal had been directed by Washington in order to stop the Japanese advance southward, to safeguard our slender communications with Australia and New Zealand, and to serve as a springboard for our counteroffensive. The nearest territory to Guadalcanal in our possession was Espiritu Santo, some 500 miles to the south.

By no stretch of the imagination could Espiritu be termed a base from which to conduct an operation. A bomber strip was built there in early August 1942. Planes could land on and take off from this strip, but there was no stock of gasoline, no gasoline storage tanks, no adequate service crews, no port facilities in the harbor. This situation, in connection with primitive roads and trails, made the movement of drummed gasoline from a ship in the harbor to the airfield a major operation.

There was a small Army garrison at Espiritu and a nucleus naval base organization. The CURTISS, a United States naval seaplane tender, was anchored in the harbor, only partially protected by mine fields. There were no wharves, no docks, no warehouses, no storage areas, no cranes, no tugs or lighters. When the combat transports and cargo ships came back in early August from the Guadalcanal landing, some of their landing craft were used in an effort to improvise a means of moving cargo.

No Cargo Facilities

Meantime, ships from the United States began to arrive in numbers with aviation gasoline, lubricating oil, ammunition, supplies, and equipment, all of which was soon to be desperately needed at Guadalcanal. Thus the Guadalcanal attack was supported from an island with no cargo-handling facilities. This, of course, had a fundamental

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continuing effect on the campaign.

A squadron of transport planes arrived at Espiritu and was thrown immediately into the Guadalcanal supply service. For some twenty days the South Pacific campaign hung on this thin thread. On several occasions the rugged pilots of these unarmed planes saved Henderson Field on Guadalcanal by the driblets of gasoline they were able to get there in the nick of time—enough to be transferred by primeval methods and to keep the combat planes flying for one more day.

Via Seaplane Tender

On other occasions, as they became available, small World War I destroyer-type seaplane tenders were loaded with all the drums they could carry and sent on their mission, with hopes that their speed, small size, and maneuverability would insure that they would get to Guadalcanal, unload and get out. They did, in spite of the fact that they were attacked by superior surface forces and by repeated bombings.

In the critical stage of the Guadalcanal fight, which lasted until November 15th, the enemy tried to sever our supply line. On five different attempts a strong group of Japanese surface vessels tried to reenforce and recapture Guadalcanal. Invariably these outnumbered our surface vessels.

We succeeded each time in obstructing their attempts to recapture the island. But had they on any one occasion destroyed our naval forces, then the thin thread of supply would have been severed permanently and the Guadalcanal position lost.

Conversely, after the Japanese commander had landed reenforcements of considerable size on Guadalcanal, he was faced with the problem of supply. We were attempting by air and surface forces to sever his supply while at the same time with our meager remaining forces to prevent him from cutting ours. And so the bitter fight went on until the middle of November when, after severe losses in a brutal night naval action, the enemy decided to let the position go. We had won the logistic battle, and the Japs had been forced to abandon a strategic keystone.

One more example of the linkage between strategy and logistics is found in the World War II invasion of Europe. For Operation Overlord, success depended among other things on two essentially logistic elements—the availability of landing ships and craft and of transport aircraft, and the capacity of beaches and ports in the lodgment area.

We were forced to postpone the landing from May 4th to June 6th chiefly because of a shortage of certain types of amphibious craft designed to carry both personnel and supplies to the beaches.

From the experience of World War II we have developed a keener and wider appreciation of the close connection between strategy and logistics. There is a very satisfying indication of this wider appreciation. The Industrial College of the Armed Forces, for instance, has splendid courses relating to industrial mobilization and stresses in its curriculum the close link between joint logistics and joint strategy.

> **"Strategy provides the scheme for the conduct of military operations; logistics provides the means for carrying out the strategic problem."**

From a naval point of view it is gratifying to watch the growth of the logistics course at the Naval War College. This was established in 1947 as an 11-month course, has continued annually since then, and has been supplemented by a logistics correspondence course.

Logistics is not a new subject, but it has expanded considerably since Biblical days. Perhaps from a naval point of view this can be visualized by the implications inherent in the difference between a fighting ship described in the Old Testament and a modern man-of-war. In the earliest days, boats were propelled relatively slowly by oars, which were usually manned by slaves. The crew normally numbered but a handful, and fighting was man to man. At night each oar-propelled craft was drawn up on the beach by the stern, and the crew cooked and slept on the land.

Today, one of our modern aircraft carriers displaces over 36,000 tons,

mounts a rapid-fire defense battery, makes over 32 knots, and carries approximately 150 modern aircraft. The ship is manned by a highly skilled team, numbering 2,800. The ship may stay at sea for months, replenished in all essential particulars by naval auxiliaries, and is ready to attack an enemy repeatedly at long range from this moving, elusive base.

Without this mobile support, she could remain in the combat area a relatively short time, and her ability to keep constant pressure on the enemy would be tremendously reduced.

To illustrate the scope and expansion of logistics, let us turn now to examine just one of its factors—movement or transportation.

Transportation had a direct and important logistic meaning when Korea was invaded. Planes, trucks, and railroads rushed large stocks of supplies to our West Coast ports in order to keep the pipeline of military supplies to the battlefront filled.

In order to get supplies to the Far East, the Navy-directed Military Sea Transportation Service added to its peacetime fleet until it consisted of over 400 ships, the majority of which were commercial bottoms. Regular naval auxiliaries augmented this total.

In addition, the Military Air Transport Service threw its weight into the problem, using military and civilian aircraft to deliver key personnel and critical materials to the battle area.

Korean Logistics

As an indication of the Korean logistic effort, the Navy delivered by sea in three months to the Army, Navy, and Air Force in the Far East over 180,000 personnel, 2,000,000 tons of cargo, and over 7,000,000 barrels of fuel. These personnel and supplies are, in convertible terms, equivalent to a train of 2,000 coaches, 26,000 freight cars, 30,000 tank cars, all loaded to capacity.

The rapidity with which sea transportation was carried out reflects a praiseworthy effort on the part of all hands of all three services. Teamwork in this emergency was outstanding. One such incident preceded the record-breaking 8-day run of the naval aircraft carrier Boxer from the West Coast to the Far East. By persistent labor and long hours the three services rushed matériel by air, railroad, and truck to the big ship. The last Army shell had hardly been loaded aboard when the Boxer steamed west carrying a capacity load of over 150 vitally needed planes for the Air Force and Navy, newly developed tank-busting bazooka ammunition for the Army, and hundreds of Army, Navy, and Air Force key fighting men.

The logistic situation at the outbreak of the Korean operation was generally satisfactory from a naval point of view. At Yokosuka, Japan, we had the use of a first-class naval base. At Sasebo we had use of another large port. At Pusan, in South Korea, there were excellent port facilities. In back of these, to the eastward, were the U. S. naval bases at Guam and Pearl Harbor, with trans-Pacific aircraft stepping-stones on various islands that had been developed during World War II.

In addition, the Navy had sufficient auxiliary ships to form and send mobile logistic support forces immediately to the Western Pacific which could refuel and rearm the ships of our naval striking forces at sea, thereby prolonging their combatant activities against the invading Reds.

We Had Learned

We reacted surprisingly well militarily in the Korean operation because we had learned the basic necessity for relating strategy to logistics. We had an organization to carry out our planning that was founded on lessons learned from the Second World War.

Two of the fundamental lessons of that war were, first, that strategic and logistic planning must be integrated and concurrent, and, secondly, that the determination of requirements for fighting a war and the control of distribution are a responsibility and prerogative of military command.

Incidentally, in reverse application, the Korean Reds felt the weight of our strategic-logistic strength in the United Nations' landing at Inchon. This landing, and the subsequent seizure of the heart of the enemy's distribution system, completely dislocated the logistic supply to his forces in South Korea and quickly led to their disintegration in that area.

Another part of our strength revealed itself in the Korean situation and this also was an outgrowth of World War II lessons. This is our present national-defense organization, which came into being with the National Security Act of 1947, amended in 1949. At the highest level, the National Security Council assisted and

appraised the objectives, commitments, and risks of the United States in relation to its actual and potential military power and made its recommendations to the President.

The National Security Council might be referred to as the strategic arm of the national-defense organization. The logistics arm, the National Security Resources Board, advises the President concerning the coordination of military, industrial, and civilian mobilization.

It is significant to note that the Chairman of the National Security Resources Board, the Secretary of State, and the Secretary of Defense are members both of the National Security Council and the National Security Resources Board, thus providing close and vital liaison between national strategy and national logistics.

At the next lower level, namely that of the Department of Defense, there are the Joint Chiefs of Staff whose functions include the preparation of strategic plans and provision for the strategic direction of the military forces. The Joint Chiefs also prepare and review joint logistic plans and assign to the military services logistic responsibility in accordance with such plans. There also is the mobilization planning agency, the Munitions Board. There are Joint Chiefs of Staff committees, and corresponding agencies of the three services, to assist in the determination of strategy and the logistic feasibility of such strategy.

More Effort Needed

Solution of logistical problems in the future will require extraordinary planning efforts as a result of the increased scope of logistics. We are engaged in greater participation in international military affairs. For instance, negotiations relative to the North Atlantic Treaty and the Mutual Defense Assistance Program create many new problems wherein there is need for concurrent planning.

A multiplicity of planning agencies has been created to deal with the international aspects of some of these programs. In addition to the need for these international planning agencies there also has been, within the nations involved, a realization that logistical planning is required throughout all national military commands.

As warfare and weapons become more complicated, the problems of logistics become greater. The logistic supply problem alone places severe limitations on strategic warfare. These limitations are particularly onerous in the opening days of a wartime emergency. Strategic plans for future warfare will not be able to contemplate any major operations during the first eighteen to twenty-four months of an emergency unless the necessary supplies are on hand at the start, or the production cycle is started well in advance.

Another factor involves our need for outside logistic assistance. The United States has about six per cent of the world's land mass, about six per cent of its population, and about sixty per cent of its production capacity.

We do not have, however, even within North America, adequate supplies of raw materials essential to wage a successful war—to manufacture, for example, enough guns, ships, airplanes, or railroad cars. To be certain of having access to these materials, it is necessary that we keep open the seas to the areas from which these materials come. Denial by an enemy of our use of these seas, or destruction of portions of our logistic production potential, would seriously affect our strategy.

"Defence of the West"

A Review of Liddell Hart's New Book on Today's Situation

by

Hoffman Nickerson

"The only chance of checking a Red Army advance long enough for the Western reserves to mobilize is by means of considerable regular forces ready for prompt transport to the theater of war"

LIDDELL HART is always a lucid, lively, and entertaining writer whose style any one might envy. In point of ideas, however, he has not always been worthy of praise. His regrettable attack on Foch's generalship descended to an ungenerous level. Much of his "Ghost of Napoleon" coincides so closely with Colin's "Education Militaire de Napoleon Premier" that readers of both have wondered why he never acknowledged indebtedness to Colin. The general drift of his praise of the defensive in his "Defence of Britain" was vehemently contradicted by the long series of brilliantly successful offensives in the Second World War.

Patton and Hart

The present book ("Defence of the West," Morrow; $4.00) suffers from the unblushing statement on pages 228 and 229 that Patton's great drive across France was inspired chiefly by a conversation with Liddell Hart himself. Those who remember Patton's dashing temperament and long study of mechanized warfare will charitably suppose that a few courteous phrases on his part may have been taken too seriously.

Similarly, it would have been more generous on page 33 to have mentioned by name a few of the British soldiers, Fuller and Martel for instance, who urged after the First World War that tank forces should be supplied by caterpillar-tractored transport.

These little shortcomings are doubly unfortunate because so much of what is said in the present book makes excellent sense. The opening seven chapters deal with certain lessons to be gained from the Second World War. Here the folly of Roosevelt and Churchill in compelling the Germans to fight to the last gasp, because of the suicidal formula of unconditional surrender, is admirably brought out.

"Those needless extra years of war" have indeed "undermined the position of Britain . . . (whose) prospects of recovery have been impaired by the disappearance of that very balance of Europe which in the past she fought so many times to maintain" (p. 60).

In the same vein, the author rightly stigmatizes the unstrategic bombing of the German cities with its militarily senseless destruction of civilian buildings and facilities which were, at best, only very distantly related to the war effort.

"Even plainer are the dire effects of the long devastation of Germany and its damaging reaction on all her neighbors in Europe. It has greatly increased the Allies' burden in . . . . trying to restore order out of the chaos created. The wholesale bombing of Germany has proved the biggest of boomerangs."

Resistance Movements

Another well-taken point is the doubt concerning the value of the active "resistance movements" on the European Continent. The encouragement of these movements, first by the British under Churchill and afterward by both British and Americans, was a popular policy. As Liddell Hart truly says, "to question its desirability was to appear lacking in resolution and almost unpatriotic."

Unfortunately it was a part of the general policy of beat-the-enemy-and-damn-the-consequences from which we are all suffering today. Meanwhile the actual military results of all these strenuously fostered guerrilla campaigns were appreciable only when they were closely combined with the operations of strong regular armies. Otherwise they were only bee stings—a nuisance but by no means a serious threat.

Passive resistance in Holland, Denmark, and Norway was almost as much of a nuisance to the German armies of occupation as the active guerrilla efforts in other countries and did not bring down upon the populations concerned the disproportionately severe retaliations with which an occupying force must always strike back.

Furthermore, in addition to the ferocity of reprisals, guerrilla warfare itself is always difficult to distinguish from common crime. When divorced from uniforms, regular discipline, and at least a semblance of rules, armed men necessarily sink toward the level of mere bandits.

Turning from the lessons which should have been learned from the Second World War to the prospects of World War III, the author naturally begins with the part which might be

Hoffman Nickerson is an outstanding military historian and author of numerous works including "The Inquisition," "The Turning Point of the Revolution," "The American Rich," "Can We Limit War?" "The Armed Horde," "Arms and Policy," "The New Slavery." He is also a frequent contributor to ORDNANCE.

played by the atomic bomb and other weapons of mass destruction. He reminds the reader of the great difference in the effectiveness of such weapons according to the nature of the target.

A little island like England, studded with cities, is highly vulnerable; a larger urbanized area like the United States is less so. The vulnerability of the vast Soviet Union is doubtful, and China is hardly vulnerable to such attacks at all. Given the present impotence of Western defense on the ground, Liddell Hart, of course, doubts the ability of air power alone to prevent advance by the Red Army.

He also notes the inappropriateness of conscript mass armies to present Western military necessities. In the past such armies, consisting chiefly of unmobilized reservists, could mobilize only because of the existence of strong "covering forces" always near the frontiers and constantly ready for action. Today no adequate covering forces exist.

Consequently the only chance of checking a Red Army advance long enough for the Western reserves to mobilize is by means of considerable regular forces ready for prompt transport to the theater of war.

Otherwise British and American universal service men of the sort interminably praised by propagandists might find the European Continent already garrisoned against them by Russians and West European fifth columnists before they themselves had finished drawing clothing and equipment.

"Neutralist Opinion"

In connection with Western Europe, with which our author, as an Englishman, is inevitably more concerned than Americans, one notes something which he implies without saying. Americans who have recently crossed the Atlantic can hardly have helped noticing the large amount of "neutralist" opinion which appears so often in conversation but never in official speeches.

Liddell Hart observes that an American-Soviet war need not necessarily begin with an invasion of the West. If it began in the Pacific it "would probably be the slowest to reach a catastrophic pitch and might be a lightning conductor for . . . Western Europe." Even an outbreak in the Near East or in Southeast Asia "might conceivably divert the lightning from quarters nearer home" (p. 75). He does not mention the word "neutrality," but from what he says one cannot fail to understand European anxiety not to be crushed between the U.S. and the U.S.S.R.

He effectively debunks the idea of air warfare across the Arctic Circle, noting that New York is closer to Soviet airfields in Eastern Germany than to the northernmost point in Russia, while we on our side would gain little in point of distance and both sides would have to contend with the special difficulties of polar flying.

In connection with Britain's military policy he justly observes that "three divisions is a very poor operational strength of an army of 375,000 men." Perhaps out of politeness he does not draw the comparison with our own Army.

Before Korea he might have been accused of undervaluing air power in comparison with operational strength on the ground, but as of today what constitutes a correctly "balanced force" between ground and air power is certainly an open question. Also that campaign should at least have taught us to take a long look at the importance of fighter planes and of tactical air in general in comparison with long-range bombers.

If the American and South Korean ground troops are driven into the sea, a considerable amount of damage from the air to North Korean rear areas will be a poor consolation. To say that fighter planes are only defensive and that offense is always the best defense is a mere parrot-cry without relation to facts. As Liddell Hart truly says, if the bombing extremists in England had succeeded in restricting the R.A.F. fighter force before World War II, the air Battle of Britain would have been lost in 1940 and Britain would have been lost with it.

In noting the resemblance between sea fighting and tank-versus-tank engagements in contrast with the difference between tanks and infantry, the present book repeats the point ably made in 1941 by John Philips Cranwell in his "Destiny of Sea Power." In point of organization, a cumbrous chain of command may indeed hinder mobility almost as disastrously as insufficient or inappropriate transport.

On the other hand, Americans will hardly go along with the idea of a permanent international armed force, since any powerful world organization —no matter how carefully federalized—would be sorely tempted to break down American tariffs and anti-immigration laws. The American standard of living would then explode like a soap bubble.

"Qualitative Disarmament"

Nor can one welcome the resurrection of the notion of "qualitative disarmament"; *i.e.*, the prohibition of certain weapons as offensive while other deadly weapons are permitted on the ground of being essentially defensive. This unreal idea, which was so deeply buried after the unhappy Geneva Disarmament Conference of 1932, should have been allowed to rest in peace. It stinks of the materialist heresy which ascribes moral values to inanimate things. Any instrument which will kill a man is capable of offensive use.

The last chapter on the "Limitation of War" inspires mixed feelings. Such an object is rational inasmuch as it has actually been achieved from time to time in the past, whereas the complete removal of organized force from human affairs is, of course, nonsense. On the other hand, the historical arguments by which it is here supported are strangely blended with gross historical errors.

The negative element in past limitations of war—*i.e.*, the mutual fear of consequences if matters are allowed to go too far—is rightly stressed in connection with the Wars of Religion. Unhappily, however, this positive element—the achievement of a working agreement as to what constitutes justice together with appropriate military instruments for protecting that agreement—is not mentioned.

The Machine Gun

Navy Bureau of Ordnance Will Publish Monumental Work

Maj. G. M. Chinn, U.S.M.C.R.

A COMPLETE history of the machine gun has been compiled by the Navy Bureau of Ordnance and will be available to the general public through the Government Printing Office in March 1951. This monumental work totals 250,000 words and includes 407 illustrations, many of them collector's items previously unpublished.

The book will provide the Army, Navy, and Air Force, as well as the interested nonmilitary, with a full compilation of data on manually operated machine guns, ground automatic machine guns, aircraft automatic machine guns, and aircraft cannon from their inception through 1950.

The four men who created "The Machine Gun"—Maj. George M. Chinn, U.S.M.C.R., Leo X. Abernethy, Franklin Clark, and M. Sgt. John H. Moore, U.S.M.C.—spent a year in research, writing, and editing. They reviewed 1,100 published volumes, plus uncounted periodicals, Government reports, and manuscripts. They had conversations and correspondence with the descendants of machine-gun designers and had contacts with libraries and museums over the world.

The authors list in this Ordnance publication what they believe to be the only collection of the automatic-weapon patents representing all nations. This compilation of 1,600 patents is not kept in such accessible form in patent offices.

The evolution of the machine gun can be readily followed through the illustrations alone, which comprise copies of letters, woodcuts, drawings, freehand sketches, daguerreotypes, and photographs.

It is my belief that "The Machine Gun" will serve well to fill a gap in the basic material available for ordnance research.
—Rear Adm. A. G. Noble, *Chief, Bureau of Ordnance, United States Navy.*

THE Bureau of Ordnance, Department of the Navy, has authorized an extensive compilation of data on the evolution of machine guns. This was prompted by the observation that practically all "new" improvements made on automatic weapons during World War II were basically older than the would-be inventor. With the end of hostilities a thorough survey of the past was undertaken in order to make available the world's recorded progress in the field of automatic weapon design.

This effort has resulted in the preparation of three volumes under the general title, "The Machine Gun." The first book is unrestricted, while the other two deal with various automatic firing mechanisms which are now in experimental form or for other good reasons are in a classified status.

The first volume was written especially for the armament student and contains approximately a thousand pages with over four hundred illustrations. It includes historical background, basic principles, photographs, and drawings. Beginning with the huge mechanical throwers of ancient and medieval days, it continues through the black-powder hand-cranked era up to and including the high-speed machine guns and aircraft cannon of World Wars I and II.

Data Authenticated

So vast a period was covered on such a highly controversial subject with practically no precedent to serve as a guide that unusual pains were taken to authenticate all data used in the text. To adhere to the old Chinese proverb that one picture is worth a thousand words, debatable features are shown by photographs. In the course of collecting research material, hundreds of books, manuals, and manuscripts from many countries, both private and government-sponsored, were examined and, after being evaluated, were microfilmed and recorded.

A review of the mass of material used in preparing the book reveals that man's desire for some form of weapon whereby crippling blows could be repeatedly rained upon an enemy from the greatest possible distance is as old as the earliest record of human existence.

The first and crudest effort was the club. Coming later, and representing the zenith of muscle-actuated devices, were the sling and bow. However, man and his mightiest mechanical contrivances were insignificant compared with the awesome force of an explosion-propelled missile. The thunder of the giant bombards of history's first great gunner, Mohammed II, at the walls of Constantinople heralded the birth of a new era.

Origin of "Machine Gun"

With the earliest development of the metal-cased center-fire cartridge (credited to George W. Morse, an American) in 1856, the term, "machine gun," entered the languages of the world. The expression itself was originally used by the patent offices of various nations to define any weapon "capable of sustained fire from energy derived from an outside source."

The manually operated machine gun period (1856 to 1883) was beyond doubt the most interesting from the standpoint of study of any given points of progression.

A good example was the Bailey gun, the first weapon to employ belted ammunition. Fortune Bailey, the inventor, decided it would be very handy to fire the round without removing it from the belt for chambering. Today he would have been told this was impossible, but, not knowing this, he proceeded to perform the feat at a rate of a thousand shots a minute! Fortunately the naval officer who conducted the test left complete drawings showing how it was accomplished. These are reproduced in the text.

However, the Gatling gun, patented by Richard Jordan Gatling of Herford, N. C., on November 4, 1862, was the

most outstanding manually operated weapon in this classification. The reliability of its mechanism can best be attested by a trial conducted by the Navy at Fort Madison, Annapolis, Md., in October 1873 in which one caliber .50/90 Gatling fired 64,000 rounds in one day. Even to suggest such a test with our "improved" machine guns of the present would be a bid for psychiatric attention.

In his lifetime Gatling saw his gun developed from "cap-and-ball" loading to the use first of rim-fire and then center-fire smokeless-powder cartridges, and from hand-cranked to full-automatic operation. It was perfected to a point where, in 1893, after being powered by an outside source, it would fire at a rate of 3,000 rounds a minute, a decent exhibition of firepower for any era. A rare letter from Gatling to Abraham Lincoln is shown in the text together with other pictures appearing for the first time in any publication.

Hiram Maxim

In 1883 an American inventor, Hiram Stevens Maxim, then living in England, succeeded in harnessing the force of each discharged cartridge to perform a complete cycle of operation. With this feat the word "automatic," was placed for the first time before "machine gun" to describe correctly "any weapon able to produce continuous fire with its source of operating power coming wholly from the explosion of the powder charge of the cartridge."

In 1887 Paul Vieille, a Frenchman, originated smokeless powder, a clean, progressive-burning compound, and by so doing removed all barriers to the principles and methods of machine-gun operation.

In a score of years practically every system of locking, feeding, extraction, and ejection known today had made its appearance in some form of automatic firing mechanism. This surge of development continued until today only a few weapons in existence tower above the others in originality. The remainder are merely within the skill of the art and do not rise to the dignity of invention.

One truth has been self-evident. Practically all good basic machine-gun mechanisms were originated by American designers.

The British Empire, the military personnel of which are undoubtedly among the best informed on the intimate mechanics and tactical employment of automatic weapons, has never in all its colorful history adopted a machine gun designed by an Englishman.

France has tried once or twice to break away from American design without great success. The machine-gun destiny of the nation was early placed in the capable hands of Benjamin B. Hotchkiss, originally from Connecticut, who started making his manually operated rapid-firing guns in the Paris factory that still bears his name. He made a revolving cannon in the late 1870's that would load, fire, and eject simultaneously, although this may be difficult to believe.

"Practically all good basic machine-gun mechanisms were originated by American designers."

Germany, which went to war twice in one generation, relied heavily on Americans for her first-line automatic weapons in preparation for World War I. The pistol commonly known as the Luger was originated and patented by a native of Connecticut, Hugo Borchardt, who was chief ordnance engineer of the great D. W. M. armament plant in Germany.

The machine gun of a Maine farm boy, Hiram Maxim, was so esteemed by the German high command that in August 1914 over 12,000 of these superb weapons were on hand with 50,000 more under production. And it should be pointed out that the first patent on the fine Mauser rifle listed a Philadelphian named Samuel Norris as conventor. A thorough review of the armament background of the principal countries throughout the world reveals that identical automatic firing mechanisms originally of American design were very often produced under a variety of names by means of a license agreement.

For instance the Maxim action, used at one time or another by almost every country under the sun, has the dubious honor of having killed and maimed more human beings than any other single man-made device yet created.

Aircraft Armament

Volume I of "The Machine Gun" also contains a chapter on the incidents leading up to the first attempt at arming aircraft and brings out the reason why aviation machine gun armament of all nations through two world wars has been based more on desperation than design. Weapons were mounted in planes and modified under critical and even combat conditions to fit the pressing circumstances at hand. "New" aircraft guns have been found to be adaptations of former ground models.

The research presented in this work should leave little doubt that from now on all large-caliber automatic machine gun design will be influenced by a specific use in aviation. The much-too-obvious errors of the past found in compiling the aircraft section of the book warrant the conclusion that the most expensive freight ever to be transported by any nation will be the second-best aircraft machine gun in another global conflict.

A New Concept?

The United States Navy has always been a technically minded branch of the armed services. With its well-ordered system of research it should anticipate the eventful day when automatic weapons will be outmoded, and it is possible that it will be the originator of any new and unusual concept of warfare.

A close study, however, indicates that any such transition will be evolutionary—not revolutionary. The unholy desire of man throughout the years to implement his belligerent impulses with superior tools for conflict has provided the anvil on which he has patiently forged what is still the most lethal scourge of war—the machine gun.

Month by Month: High Lights of the National Defense

PEACE TO WAR

A midcentury report on the state of our national defense is particularly timely. Less than six years after the greatest war in history, ruthless armed aggression again stalks the world. This menace to our survival as a free people erupted on June 25, 1950, in the naked aggression by Communist forces against the Republic of Korea in willful and wanton violation of all principles of human decency and international law.

> *How well prepared were we to resist aggression? What was the peacetime strength of our Nation? What was the base upon which is now being reared the current multi-billion-dollar armament program?*

The facts are to be found in the Semiannual Report of the Secretary of Defense, covering the period January 1 to June 30, 1950.

Personnel

At the end of the fiscal year 1950 there were about 1,461,000 men and women on active duty in our armed forces, of whom about 593,000 were in the Army, 382,000 in the Navy, 75,000 in the Marine Corps, and 411,000 in the Air Force.

The Regular forces were backed by National Guard and Reserve forces with more than 2,500,000 members. The Army National Guard numbered 325,000 and the Air National Guard, 45,000.

Twenty-six of the twenty-seven divisions authorized for the Army National Guard had completed their organization, and the remaining division lacked only one unit.

The Air National Guard had completed the organization of its 516 units.

In both organized and volunteer units the Army had 187,000 officers and enlisted men in drill-pay status on June 30, 1950, the Navy 181,000, the Marine Corps 40,000, and the Air Force 58,000. There were also 219,000 high-school and college students enrolled in junior and senior R.O.T.C. programs.

The Army consisted of ten divisions, with additional regimental combat teams and support and supply units. It had some deficiencies in equipment. The Army's actual strength of 593,000 was temporarily nearly 40,000 below the budgeted strength because of its effort to change to a total volunteer basis.

Yet the ratio of Army personnel in combat units to total Army strength was at its highest point since demobilization. At the time of the Korean invasion, 43 per cent of the Army's military personnel was in combat units, as compared with 28 per cent in 1948, with the number of combat personnel increased by over 67 per cent.

> *Our Navy, although greatly reduced from its wartime strength, remains the most powerful in the world. It is capable of early expansion to meet its responsibilities for sustained combat.*

During the first six months of 1950 the Navy devoted particular attention to antisubmarine warfare, for which funds were increased 200 per cent. The Marine Corps continued to develop its proficiency in amphibious operations and to test new and more effective techniques and tactics in numerous maneuvers.

The Air Force, with its B-36 bombers, is capable of carrying out its primary mission of strategic air warfare anywhere on the globe. Our ground and tactical air forces were much more closely coördinated. The Air Force's state of readiness was at the highest point since demobilization. The number of groups operationally ready for action increased by almost fifty per cent during the last two years. The number of aircraft in many bombardment groups was raised considerably.

Unification continued to increase the teamwork of the Army, Navy, and Air Force. Large-scale joint maneuvers not only improved the readiness of our armed forces but also trained them to operate together under conditions similar to those they would encounter in actual combat.

Joint education of officers and enlisted men was given greater emphasis. Further advances were made in joint research and development and in common procurement and other aspects of industrial mobilization. Teamwork became less and less a matter of formal directive and more and more of instinctive action.

Research Activities

The Department of Defense spent about 550 million dollars to defray the direct costs of military research and development. This sum represented a little less than four cents out of every dollar appropriated for national defense.

> *These programs touched practically every field of science. More than ten thousand separate projects were approved to cover the vast variety of items on which our armed services must work to provide adequate technological support for combat units.*

While much work was done in military and other Government laboratories, the larger portion was carried on through contracts with industrial establishments, commercial firms, universities, and other research institutions.

Industrial Mobilization

More than seventy programs designed to improve industrial activities or to perfect industrial-mobilization plans and supply-management techniques were developed by the Munitions Board. The ingredients of production, whether in peace or war, are plants, tools, materials, and manpower. It is the task of the Munitions Board to arrange for bringing these ingredients together in wartime in

proper proportions at the proper time.

A total of 454 manufacturing plants and other war facilities built by the Government during or before World War II were retained in reserve for wartime use. Of these, 260 were in the Department of Defense Industrial Reserve under the direct control of the military departments, including 54 arsenals, shipyards, and similar permanent military establishments.

The other 194 were in the National Industrial Reserve, which included plants that had been or may be sold or leased, subject to the National Security Clause stipulating that they will be kept in condition to begin their planned war production within 120 days.

Of the 400 reserve plants not in the permanent military establishment, 269 were sold, leased, or in governmental use, 23 were partly sold or leased, and 108 were idle.

Of the 454 in both reserves, 430 were capable of manufacturing products required by the Army, Navy, and Air Force, 16 were research facilities, and 8 were oil pipelines, terminals, or other nonmanufacturing facilities.

Seventy of the plants produce base materials for which the National Security Resources Board assumed mobilization planning responsibility, while the military departments were responsible for planning mobilization production of all other plants in the two reserves.

Another major program of the Munitions Board involved machine tools and industrial equipment. The objective was to acquire and maintain reserves that could be used to expand industrial production in an emergency. There were 126,000 of these items in reserves owned by the Army, Navy, and Air Force.

These tools were obtained from Government surpluses and were in addition to those in reserve plants. Additional tools and equipment were placed in the National Industrial Equipment Reserve, consisting of about 19,000 major items stored and maintained for the Department of Defense.

Supply Management

On the purchasing side of our military supply system, the Department of Defense worked on programs to increase its efficiency. One such program involved the establishment of uniform procurement regulations that formed a basis for common and improved practices and procedures covering such matters as methods of procurement, contract forms and clauses, patents and copyrights, bonds and insurance, taxes, labor, material inspection and acceptance, contract cost principles, and pricing and profit policies.

Most of these regulations have been published and should make it easier for industry to do business with the military. Drafts of revisions to make these regulations applicable to mobilization were prepared.

A new system was introduced by which information about competitive bids and contract awards was made available daily at more than 1,800 locations in over 800 cities in the United States and Hawaii through the cooperation of the Department of Commerce.

The information was available at Chambers of Commerce, State employment bureaus, business association headquarters, Department of Commerce field offices, and similar organizations.

The Munitions Board sought to expedite work on a single Federal supply catalog system for the millions of items purchased, stocked, and issued by the Army, Navy, Air Force, and civilian agencies. The purpose of this program was to have each item identified by a standard name, description, and identification number in the supply system of all the organizations that use the item.

No one knows exactly how many listings there were of the items bought during World War II, but it was estimated that there were more than 5,000,000. There was a great deal of needless duplication, confusion in distribution, and outright waste. The expectation was a reduction of this very large figure to approximately 2,500,000 by eliminating duplicate listings of the same item.

At the beginning of the calendar year 1950 the Munitions Board Cataloging Agency had completed about 13 per cent of its program to name, describe, number, and classify in a uniform manner each of the estimated 2,500,000 supply items procured by the armed services.

During a 6-month period the agency approved 543,000 item descriptions, bringing the total to 877,000 or 35 per cent of its estimated goal. When completed and in full use the system will effect major efficiencies in supply management operations.

Cost of Preparedness

The aggregated amount appropriated for the Army, Navy, and Air Force for the five fiscal years of 1946-1950 totaled 90 billion dollars. Of this amount, approximately 42 billion, or 45 per cent, went to pay for the cost of liquidating World War II.

During the postwar years the Nation incurred heavy costs for maintaining the peace in distant lands. Nearly half of our Army has been maintained overseas in occupied countries in Europe and Asia.

We have had to bear the costs of having substantial portions of our Navy in the Mediterranean in the interest of maintaining world peace, and we had to bear the costs of saving Berlin with the airlift.

During the past four fiscal years the money needed to pay, feed, and clothe the men and women in our armed forces has averaged about 5 billion dollars a year, or 41 per cent of the 4-year average of approximately 12 billion dollars a year.

An average of 3 billion dollars a year, or 26 per cent, went to meet the cost of operating and maintaining the aircraft, ships, tanks, and military installations that went to make up our military strength.

Major procurement—aircraft, ships, tanks, and other weapons—accounted for approximately 2¼ billion a year, or 18 per cent. It is worthy of note that the percentage of the annual total that has gone into major procurement increased from a low of 6 per cent in the fiscal year 1947 to a high of 19½ per cent in the fiscal year 1950. It is also worthy of note that 60 per cent of

the President's recommended 10½ billion dollar supplemental budget was for major procurement.

Over the 4-year period, research and development on new weapons accounted for approximately 5 per cent, or an average of slightly more than one-half billion a year.

MILITARY CONTRACTS SPREAD

The Secretary of Defense, Gen. George C. Marshall, has called upon the Army, Navy, and Air Force to spread contracts across industry as widely as possible in order to broaden the scope of the military procurement program, to obtain urgently needed goods faster, and to take up the slack in industries now facing cutbacks because of materials shortages.

The directive to the military Departments, which was based upon recommendations of the Department of Defense Munitions Board, also is designed to afford greater security by bringing a greater number of firms into military production and to insure that the build-up of procurement will follow mobilization programs which have been developed by the Munitions Board, the military Departments, and industry.

> *The declaration of a National Emergency by the President now permits the Secretaries of the military Departments to authorize the negotiation of purchases and contracts as provided for in the Armed Services Procurement Act of 1947.*

General Marshall said that the Departments already have been instructed to speed up procurement actions in connection with the Second Supplemental 1951 Funds request so far as can be done in advance of its approval by Congress.

In his directive General Marshall set down ten major points to which the military Departments should pay particular attention:

1. The greatest possible integration of current procurement contracts with the industrial-mobilization program and the accepted schedules of production. (More than 10,000 plants now have these schedules, developed by agreement between plant management and the military services under the Production Allocation Program directed by the Department of Defense Munitions Board. Schedules with several thousand other plants are in the process of completion.)

2. The equitable distribution of procurement contracts among a number of competent suppliers. The concentration of contracts with a few leader suppliers is to be avoided unless the necessity therefor is clear.

3. The utilization of existing open industrial capacity to the maximum. Expansion of facilities should not be authorized when open capacity can be found. Whenever time permits, and in order to broaden the mobilization base, additional contractors should be utilized in lieu of multishift or overtime operation.

4. The fullest possible use of small business concerns.

5. Utilization in negotiation of competition and multiple awards, whenever possible.

6. The aggressive encouragement or requirement of subcontracting by prime contractors.

7. Provision of maximum incentive to the producer for the reduction of his costs.

8. Placement of contracts with a view to economies in the use of transportation facilities.

9. The availability of manpower in distressed employment areas or in areas of manpower shortages.

10. The reservation of special skills and abilities for the more difficult production tasks.

SURVIVAL UNDER ATOMIC ATTACK

This is the title of a little booklet just issued by the Civil Defense Office of the National Security Resources Board. There is no need to comment upon its timeliness. Here are put down in simple terms the steps an individual must be prepared to take to survive under atomic attack. The booklet is published by the United States Government Printing Office and is for sale by the Superintendent of Documents, Washington 25, D. C., at 10¢ each.

The chances of survival if a modern A-bomb exploded without warning in the area over your home town are in this order:

1. If you are right under the bomb there is practically no hope of living through it. There is nothing new in that statement for it applies as well to any type of major explosive, be it TNT, RDX, or any of the high explosives which have long been known and used in warfare.

2. If you are from one-half to one mile away you have a 50-50 chance; from 1 to 1½ miles the odds that you will be killed are only 15 in 100; at points from 1½ to 2 miles away deaths drop all the way down to only 2 or 3 out of each 100. Beyond 2 miles from the explosion there are practically no deaths at all.

> *Chances of being injured are naturally far greater, as the pamphlet says, "but injury by radioactivity does not mean that you will be left a cripple or doomed to die an early death. Your chances of making a complete recovery are much the same as for every-day accidents. These estimates hold good for modern atomic bombs exploded without warning."*

To explain the principal steps to be taken in greater detail than is possible in these pages, there is published as Section II of this issue of ORDNANCE magazine a special diagram outlining recommended procedures in the event of an atomic attack. The diagram is based upon the information contained in the Government brochure. It was prepared at the request of the editors of this magazine for our readers by Will Eisner, well-known Ordnance artist, the first of whose latest series of drawings was published in our last issue.

It is our hope that this diagram with its simple and direct message will elaborate sufficiently these few words on a subject which can be of vital importance to all Americans during these days when the outlook for peace is so remote. If the accompanying diagram performs its function it will have served a most useful purpose.

ASSOCIATION AFFAIRS

• **FOR ARMY RELIEF**—A check for $1,374.63 was presented to the Army Relief Society at the Aberdeen Proving Ground by the American Ordnance Association as a contribution to Army Emergency Relief. This fund represented the excess of income over expenditure in connection with the Thirty-second Annual Meeting of the A.O.A. at Aberdeen on October 5, 1950. The check was presented by James L. Walsh, president of the Association, to Lieut. Col. Samuel W. Parnelle, Jr., Army Emergency Relief Campaign chairman at Aberdeen. The presentation took place in the presence of Maj. Gen. E. E. MacMorland, commanding general of the proving ground. This donation on the part of the Association is customary in all activities of the A.O.A. at Government establishments where admission charges are made.

• **HAIL THE MARINES!**—The valiant United States Marine Corps was the object of an historic tribute by the Ordnance Association on December 6, 1950, when more than 1,700 members and their guests filled the huge ball room of the Waldorf-Astoria Hotel, New York City. The honor guest and principal speaker was Gen. Clifton B. Cates, Commandant of the Corps. The occasion was the Thirty-second National Dinner Meeting of the Ordnance fraternity under the auspices of the New York Post.

Vice Adm. George F. Hussey, Jr., president of the Post, presided at the meeting. James L. Walsh, president of the national Association, was toastmaster. The invocation was pronounced by the Rev. Daniel K. Poling, a minister of the Collegiate Church of the City of New York.

Preceding General Cates' address, which is published in full in this issue (see page 278), Herbert A. Gidney, vice-president of the Association and chairman of the General Committee on Aims and Organization, reported to the assembled members on the work of that committee which has resulted in revisions of the constitution and by-laws. Colonel Gidney's remarks were published in full in the January issue of the Association's newsletter, THE COMMON DEFENSE. In addition to the above, the following leaders of American industry and of the armed services were among those seated at the dais:

Adm. W. H. P. Blandy, Chief, Bureau of Ordnance, U. S. Navy, 1941-1943; E. K. Gudtrey, member of A.O.A. Council; Maj. Gen. E. L. Ford, Chief of Ordnance, U. S. Army; R. E. Gillmor, director, A.O.A.; Hon. Earl D. Johnson, Assistant Secretary of the Army; C. E. Wilson, member, A.O.A. Advisory Board; Lieut. Gen. K. B. Wolfe, Deputy Chief of Staff, Materiel, U. S. Air Force; Thomas E. Murray, member, Atomic Energy Commission;

Harvey C. Knowles, vice-president, A.O.A.; K. T. Keller, director, A.O.A.; Hon. John T. Koehler, Assistant Secretary of the Navy; Lieut. Gen. Willis D. Crittenberger, commanding general, First Army; Hon. John F. Floberg, Assistant Secretary of the Navy for Air; B. F. Fairless, consultant to the Chief of Ordnance, U. S. Army, 1942-1946; Rear Adm. Albert G. Noble, Chief, Bureau of Ordnance, U. S. Navy; Lieut. Gen. Levin Campbell, Chief of Ordnance, U. S. Army, 1942-1946; Maj. Gen. A. W. Vanaman, commandant, Industrial College of the Armed Forces;

Maj. Gen. G. M. Barnes, president, Philadelphia Post, A.O.A.; Rear Adm. W. A. Kitts, III, commandant, U. S. Naval Proving Ground, Dahlgren, Va.; John Slezak, director, A.O.A.; Henry P. Erwin, treasurer, A.O.A.; Robert L. Biggers, member, A.O.A. Advisory Board; Lieut. Gen. E. H. Brooks, Assistant Chief of Staff, G-1, U. S. Army; Louis Polk, president, Cincinnati Post, A.O.A.; Frederick H. Payne, director, A.O.A.; Maj. Gen. M. H. Silverthorn, Assistant Commandant, U. S. Marine Corps; John Ross Delafield, counsel, A.O.A.;

Lieut. Gen. Henry S. Aurand, U. S. Army, Pacific; John G. Phillips, chairman, New York Committee, A.O.A.; Ferdinand Eberstadt, Chairman, Munitions Board, 1942; Maj. Gen. Floyd L. Parks, Chief of Information, U. S. Army; C. Stewart Comegys, member of A.O.A. Council;

Maj. Gen. R. C. Coupland, commanding general, Air Materiel Armament Test Center, Eglin Air Force Base, Fla.; Rear Adm. P. B. Niebecker, commandant, New York Naval Shipyard; Frank M. Edson, chairman, National Security Industrial

> **"I deeply regret that I cannot be with you December 6th as the American Ordnance Association honors the United States Marine Corps. For 175 years the United States Marines have answered this nation's call with valor and distinction. On behalf of soldiers, sailors, and airmen everywhere, may I offer a soldier's salute to the Corps, its fine record in the past, and its valorous record that is being forged on the fields of battle today."**—GENERAL OF THE ARMY OMAR N. BRADLEY, *Chairman, Joint Chiefs of Staff.*

> **"Please add my congratulations and good wishes as the American Ordnance Association pays tribute to the United States Marine Corps on the occasion of the Association's Thirty-second Annual Dinner Meeting. For 175 years the Marines have shown their willingness to offer themselves in battle in the cause of their country's beliefs. Their record has been inspiring."**—GEN. HOYT S. VANDENBERG, *Chief of Staff, United States Air Force.*

> **"Hearty congratulations to the members of the American Ordnance Association as you celebrate your own Thirty-second Annual Meeting and the 175th anniversary of the United States Marine Corps. It is fitting indeed that such a splendid tribute be paid the Marine Corps at this time when Marines, side by side with their comrades in the Army, are contributing so much to the United Nations battle for freedom in Korea.**
>
> **"It is also most appropriate that tribute be paid to the American Ordnance Association during these trying times when the closest cooperation between the armed services and American industry is so tremendously important. You have my warmest best wishes for a most successful occasion."**—GEN. J. LAWTON COLLINS, *Chief of Staff, United States Army.*

E. R. Godfrey (left), Louis Polk, Gen. Clifton B. Cates, and James L. Walsh chat before the Association's Thirty-second National Dinner in New York on December 6, 1950.

Association; C. K. Davis, chairman, Small Arms and Small Arms Ammunition Division, A.O.A.; Brig. Gen. D. J. Crawford, commanding general, Detroit Arsenal; J. E. Trainer, chairman, Artillery Division, A.O.A.; Maj. Gen. William O. Reeder, Deputy Assistant Chief of Staff, G-4, U. S. Army; Maj. Gen. R. L. Maxwell, chairman, Industrial Preparedness Committee, New York Post, A.O.A.; Rear Adm. J. A. Snackenberg, Deputy Chief, Bureau of Ordnance, U. S. Navy; John M. Olin, member, Advisory Board, A.O.A.; Maj. Gen. Franklin A. Hart, commanding general, Marine Corps School, Quantico, Va.;

Brig. Gen. Leslie E. Simon, chief, Ordnance Research and Development Division, U. S. Army; George C. Brainard, chief, Cleveland Ordnance District; Rear Adm. G. L. Russell, Judge Advocate General, U. S. Navy; Brig. Gen. Joel G. Holmes, field director of Army Ordnance ammunition plants.

• **LANSING CHAPTER.**—Rear Adm. J. A. Snackenberg, Deputy Chief, Navy Bureau of Ordnance, was guest speaker at the launching of the Lansing Chapter of the Michigan Post on November 29th. Speaking in Lansing, Admiral Snackenberg said, in part:

"We here tonight have a major part to play in the planning and execution of the national effort. It is, we may be thankful, a concrete job that practical men can understand. We have the opportunity, through the American Ordnance Association, to identify the industrial strength of the United States so intimately with the measure of military power that they may be called factually 'one and inseparable.'

"We must, I feel, present in this light our part of the picture of the national potential for the conduct of war. No country in the world can fail to comprehend the implications if our industry is prepared to divert its strength rapidly and completely from the production of the plowshares of peace to the sharp swords of war—especially if this capability is made widely known by appropriate means. Through the mutual efforts of representatives of industry and of the armed forces in the American Ordnance Association we have made excellent progress—phenomenal progress, if we look back to the days of World War I."

• **CINCINNATI POST.**—An overflow gathering of members and guests of the Cincinnati Post attended a dinner meeting on November 21st at which the principal speaker was Brig. Gen. Leslie E. Simon, chief of the Army Ordnance Research and Development Division.

This annual meeting of the Post was further marked by the presentation of the Charles L. Harrison Medal, awarded for distinguished service to Ordnance. The recipient was Edward A. Muller, early chief of the Cincinnati Ordnance District and veteran producer of machine tools. In the unfortunate absence of Mr. Muller due to illness, the medal was received by Charles Muller, his son.

Many distinguished guests, from industry, public life, and the armed services joined Louis Polk, president of the Post, at the speakers' table.

• **YANKEE POST.**—The dinner meeting of the Yankee Post which was held in Boston on December 6th, was devoted to Post business and a most timely talk on "Military Pricing and Financing." The speaker was Ross Pancoast, chief of Financial Services, Office of the Ordnance Controller.

Because of the recent great increase in the placing of military orders in the area, and their rather complex financing, the competent talk of Mr. Pancoast and the question period which followed proved of immense value to all who attended.

• **CAPITAL CITIES POST.**—Hiland G. Batcheller, president of the Capital Cities Post, last fall announced a plan to mobilize all potential defense goods producers in northeast New York State. This most vital and intensive effort is directed by the Post's committee on industrial preparedness, under the leadership of John O. Amatuz.

The Post seeks to determine all potential defense producers, no matter how small, in its 13-county area. After completion of its survey, the committee plans to act as a service agency to assist qualified manufacturers in obtaining and fulfilling defense contracts.

A long step in this direction was the dinner meeting held at the Circle Inn, Lathams, N. Y., on December 11, 1950. The keynote of the meeting was the work of the industrial preparedness committee and assistance to local contractors. Lieut. Col. Albert C. Lazure (Ord. Res.), chief of the Legal Division, Office of the Chief of Ordnance, and an authority on Ordnance contracting, was the speaker.

Maj. Gen. E. E. MacMorland, commanding general of Aberdeen Proving Ground (left) looks on as Lieut. Col. S. W. Parnelle, Jr., chairman of A.P.G. Army Emergency Relief campaign, receives a $1,574.63 check from James L. Walsh, A.O.A. president.

Attended annual meeting of the Syracuse-Central New York Chapter, Empire Post. *Seated, left to right: Carl Dietz, president of Lamson Corporation; Rear Adm. A. M. Pride, Chief of the Navy Bureau of Aeronautics; Philip F. Glasier, vice-president, Easy Washing Machine Corporation, retiring chapter president; Col. H. H. Isaac, deputy chief, Rochester Ordnance District. Standing, left to right: C. D. Osborne, publisher, Auburn Citizen-Advertiser; J. D. Williams, vice-president, Lyon Railway Corporation, new chapter chairman; R. C. Mahon, vice-president, Firestone Tire & Rubber Company; Comdr. G. E. Hocum, inspector of naval materials, Syracuse.*

• **PITTSBURGH POST.**—The Pittsburgh Post and the Pittsburgh Ordnance District held a joint dinner meeting in November at which more than 400 A.O.A. members enjoyed a talk by Rear Adm. Albert G. Noble, Chief of the Bureau of Ordnance, U. S. Navy. Admiral Noble spoke on "Our Responsibilities in the Present International Situation."

Lieut. Gen. James A. Van Fleet, commander of the Second Army, was an unexpected visitor and joined the other distinguished guests and Ordnance leaders at the speakers' table. He also spoke on the military situation. T. H. Eddy, president of the Post, presided, and the toastmaster was R. C. Downie, chief of the Pittsburgh Ordnance District. James L. Walsh, national president of the A.O.A., illustrated a short talk with appropriate charts.

• **LOS ANGELES POST.**—The Los Angeles Post recently offered to a limited number of its membership a full day's demonstration at the U. S. Naval Ordnance Test Station, Inyokern, Calif. The field trip was made by means of chartered airplanes.

The demonstrations included the firing of tests of various types of rockets and a tour of the Michelson Laboratory, one of the largest existing plants of its kind.

The visit offered an opportunity to the engineers and industrialists of Los Angeles to acquaint themselves with vital ordnance materiel which they must produce in event of war. J. D. Spalding, president of the Post, led the inspection trip.

• **ARTHUR G. DREFS**, a member of the Council of the American Ordnance Association, a director of the Association's St. Louis Post, and chairman of the board of McQuay-Norris Manufacturing Company, died in St. Louis on November 1, 1950. He and his company contributed in great measure to the success of the Ordnance production program in the Second World War. In his death the Industry-Ordnance Team has lost a member whose loyalty to the national defense of our country was of the highest degree.

Born in Buffalo, N. Y., Mr. Drefs was graduated from the University of Pennsylvania in 1909. His first employment was with Miller, Franklin, Stevenson & Company, industrial engineers. He remained with the company, which in 1912 became Miller, Franklin & Basset, until 1917 when he resigned to enter war service as chief of the Administrative Branch of the Motors and Vehicles Division of the Army.

In 1921 he became vice-president and director of McQuay-Norris Manufacturing Company. He was elected president of the company in 1943 and chairman of the board in 1950.

His wide range of industrial and civic activities is best indicated by his service as a member of the boards of directors of many important organizations.

Mr. Drefs throughout the Second World War directed many of the operations of his company on ordnance production, most notable among them being the phenomenally successful production of VT fuzes. Following the war he maintained his close interest and cooperation with Ordnance affairs through service on important committees and groups of the Ordnance Association.

In his death American industry and our national defense have lost a valiant member and a loyal friend.—L. A. C.

• **HERBERT W. ALDEN**, a founder of the American Ordnance Association and director of engineering of the Timken-Detroit Axle Company, died at Trenton, Mich., on November 11, 1950. A charter member of the Association, he had served on the original committee on organization in 1919. His active interest and deep allegiance to Ordnance during more than a third of a century had never wavered.

A native of Vermont, Colonel Alden was graduated from Massachusetts Institute of Technology in 1893 and began his active industrial career as assistant engineer of the American Projectile Company, Lynn, Mass. In 1895 he began his lifelong service to the automotive industry of the United States, beginning with the Pope Manufacturing Company. He served on the staff of the Timken Roller Bearing Company from 1906 to 1909, becoming chief engineer of Timken-Detroit Axle Company in 1909, vice-president in 1913, chairman of the board in 1926, and director of engineering in 1941. In collaboration with Col. G. A. Green of H. M. Royal Engineers, he designed the Inter-Allied Mark VIII tank of World War I fame.

In the field of ordnance technology Colonel Alden's greatest contribution was made as a member of the Ordnance Automotive Advisory Committee throughout all the years between the two world wars.

In recognition of his outstanding contribution to the United States Army and to American industry he was cited on many occasions. From the Ordnance Association in 1941 he received the Frank A. Scott Gold Medal for preeminence in the advancement of industrial preparedness; from the Automobile Old Timers he received in 1946 the Distinguished Service Citation. For his service in World War I he was awarded the Distinguished Service Medal. As a colonel in the Ordnance Reserve Corps he rendered conspicuous service for many years.

Colonel Alden was a founder member of the Society of Automotive Engineers of which he was a vice-president. He was a fellow of the American Society of Mechanical Engineers and a charter member of the Automobile Old Timers Association.

His life work for the automotive industry and the national defense of his country was of such high character that his memory will long remain as that of an ideal engineer, citizen, and soldier. In all his works he was a symbol of extraordinary courage and independence.—L. A. C.

New DEVELOPMENTS

U. S. AND SOVIET ARMS

Quality of design and manufacture of Soviet weapons is good according to a recent U. S. Army report and compares favorably with U. S. weapons. The firepower of the Russian infantry division, reported to be only about sixty per cent as large as its U. S. counterpart, is comparatively high, partly because the Russians use considerably more submachine guns as individual weapons. All told, the individual-weapon list shows greater numerical superiority on the side of the U. S. According to a national weekly magazine, one American division is armed with 7,156 rifles and 7,474 carbines, both cal. .30, and 631 cal. .45 submachine guns.

The U. S. division has about fifteen per cent more crew-served automatic weapons and about forty-five per cent more mortars than the Soviet division. Russian mortars, however, are preponderantly of heavy types. The Russian heavies are used tactically in much the same way as U. S. howitzers of similar caliber. Field-artillery pieces in the American division, consisting of about fifty-four 105-mm. howitzers, and eighteen 155-mm. howitzers, outnumber those in the Red infantry divisoon by some sixty per cent. The lighter 76-mm. and 85-mm. Soviet weapons are high-velocity guns which can be used for antitank work. Reportedly the Russians have no counterpart of U. S. recoilless rifles.

Both the U. S. infantry and armored divisions have more tanks than their Russian counterparts, though the Soviets use a considerable number of self-propelled guns. Antiaircraft artillery is far superior in numbers in the U. S. divisions. The Army has concluded that both U. S. infantry and armored divisions can generate firepower about 1½ times that of Russian divisions, without reference to the discrepancy between the relative size of the divisions.

"DEATH SAND"

An invisible dust of radioactive "death sand" could be spread over cities of the earth and kill their populations by radioactivity according to Dr. Louis N. Ridenour, dean of the University of Illinois Graduate School, in a report appearing in the *Bulletin of the Atomic Scientists*. Very fine sand could be coated with radioactive poisons and spread very thinly over the area where it is desired to wipe out life. It is estimated that half an hour of breathing dust stirred up by passing winds would give a fatal internal dose.

NEW LIAISON HELICOPTER

The Navy has ordered a limited number of a new liaison-type helicopter designed to carry a pilot and three passengers and to be readily converted into an aerial ambulance for two stretcher patients and a medical attendant. The new helicopter, the Kaman HOK-1, will have twin intermeshing rotors, with the pitch of the rotor blades being changed by a small servocontrol. A single engine will drive both rotor blades.

PLASTIC TESTS ORDNANCE

An improved plastic, which can be made into exact, lifelike models of machine parts and tools, will have a major part in the design of breechblocks for artillery weapons. The "photo-plastic," developed by two technicians at the Westinghouse Research Laboratories, is intended to enable scientists to get a thorough picture of the strains encountered in the manufacture of metal items. It can be cast in pieces from ten to twenty times as large as resins formerly available for strength and stress studies.

For breechblock testing, laboratory workers build an exact three-dimensional model of the block and freeze in the plastic. When the block is viewed under special polarized light, the stress pattern appears as a series of varicolored lines or fringes which indicate the location and degree of major stresses.

NEW ANTITANK WEAPON

A new antitank weapon previously shrouded in secrecy was announced to the public for the first time recently. It is the 105-mm. recoilless rifle mounted on a jeep. The easy-to-handle antitank rifle, operated by a 2-man crew, is normally fired from the back of the jeep which makes it a highly mobile weapon with a terrific punch. It is the largest recoilless rifle

The new 105-mm. recoilless rifle.

not only in caliber but in size and weight as well. The 105-mm. recoilless rifle is an outgrowth of the experience gained in the design and development of smaller-caliber recoilless weapons.

CHEAPER SMOKELESS POWDER

Smokeless powder can now be made more cheaply and quickly, due to a development of the U. S. Department of Agriculture's Southern Regional Research Laboratory. It consists of a better method of taking sulfuric acid out of the finished guncotton. The explosive is made by nitrating the short fibers left on cotton-seed after ordinary ginning of cotton. Sulfuric is used to help along the process but it must be washed and boiled out, otherwise the powder will be unstable and decompose when stored.

FLYING GAS STATIONS

The first of the new type KB-29P flying-boom aerial tanker airplanes was recently delivered to the 97th Aerial Refueling Squadron at Biggs Air Force Base, Tex. The new "aerial gas station" makes possible the refueling of U. S. Air Force bombers at higher speeds and greater altitudes and at a much faster rate of flow than was possible with earlier fueling systems.

The aerial tanker, first delivered to the new squadron, is a modified B-29 Superfortress. The new flying-boom system utilizes a long telescopic refueling pipe extending from under the tanker's tail. It is controlled by unique "ruddevator" surfaces, which enable the operator, seated in the tanker's tail section, actually to "fly" the refueling nozzle into contact with the airplane requiring fuel.

HYPERSONIC WIND TUNNEL

Speeds of more than ten times the velocity of sound are being obtained in the recently completed hypersonic wind tunnel on the campus at the California Institute of Technology, Pasadena, Calif. The tunnel was designed and built for the institute and Army Ordnance to provide vitally needed information for use in the design of future missiles at speeds well above those of present-day rockets and missiles.

New Developments

NEW R. AND D. COMMAND

The Air Force's Air Research and Development Command, established as a planning unit last January, is scheduled to begin operating as an independent, major U.S.A.F. command by May 15, 1951. Interim headquarters will be located at Wright-Patterson Air Force Base, Dayton, Ohio. Under present plans, the Arnold Engineering Development Center at Tullahoma, Tenn., now operating directly under the Chief of Staff, and the Electronics Development Center at Griffiss Air Force Base, Rome, N. Y., will be assigned as major divisions of the Air Research and Development Command.

HELICOPTER TRANSPORT

Transport companies equipped with helicopters designed for Army combat operations and logistical support are being organized for use in corps, divisions, and smaller tactical units. Each company will be equipped with twenty-three helicopters. Two of the aircraft will be used for command and reconnaissance purposes; the other helicopters will be of the light cargo type for transport of men, equipment, and supplies. Helicopter-equipped companies, it is anticipated, will facilitate river crossings and special types of operations which may be required for arctic, amphibious, mountain, and jungle warfare where movement of vehicles on the ground can be extremely difficult.

NEW AMMUNITION CENTER

The Department of the Army announced recently the establishment of an Ordnance Ammunition Center at the Joliet Arsenal, Joliet, Ill. The center will decentralize the ammunition program to a point away from Washington, D. C., where most of the work was performed during World War II, thereby avoiding a personnel expansion for this purpose in the Capital. Its location at Joliet also will place the proposed new control center at a point geographically desirable, particularly in regard to accessibility to major ammunition-manufacturing activities. The function of the center will be to procure the bulk of Ordnance ammunition, to command all Ordnance loading, explosive-powder and chemical plants, and to supervise renovation and demilitarization of ammunition.

AIRLIFT 4-0-4

The U. S. Navy and the U. S. Air Force have been given specifications for a new combination twin-engined trainer, staff transport, and utility cargo airplane designated the Martin "Airlift" 4-0-4. Having characteristics, pay load and versatility comparable to those formerly assigned to 4-engined aircraft, yet retaining the many advantages of 2-engined airplanes, the Airlift 4-0-4's basic mission will be to carry a 15,000-pound pay load over a combat range of 1,500 miles at

The Martin Airlift 4-0-4.

270 miles an hour. The piston-engined version of the 4-0-4 is shown in the artist's conception above.

SUPERSONIC PROPELLERS

An advanced series of subsonic, transonic, and supersonic propellers which will pave the way to the eventual attainment of speeds up to 1,000 miles an hour with long-range, propeller-driven bombardment, troop-carrying, and transport aircraft, was revealed recently by the Propeller Division of the Curtiss-Wright Corporation, Caldwell, N. J. Initially, the newly announced propellers will be used in aircraft capable of cruising at 500 to 600 miles an hour. However, the research on which they are based indicates that twice these speeds can be achieved in propeller-driven aircraft of the future.

RUBBER FROM WOOD

Raw material for tomorrow's synthetic rubber may be obtained from waste from the manufacture of paper from spruce wood. This new rubber-making chemical is called PADMS, which is short for para alpha dimethyl styrene. It is said to be able to replace the usual styrene that combines with butadiene to make GR-S synthetic rubber, now in largest production.

NEW LIFE RAFT

A completely new 20-man life raft developed by the Air Matériel Command's Aero Medical Laboratory holds 5,000 pounds, can withstand 60-knot winds, and inflates automatically when launched. Built like a seagoing doughnut, the raft features a circus-tent nylon canopy dyed a high-visibility red on one side and camouflage sea-blue on the other. It comes complete with radar reflector and an extensive survival kit. Four hundred rafts are on order for planes of the Military Air Transport Service.

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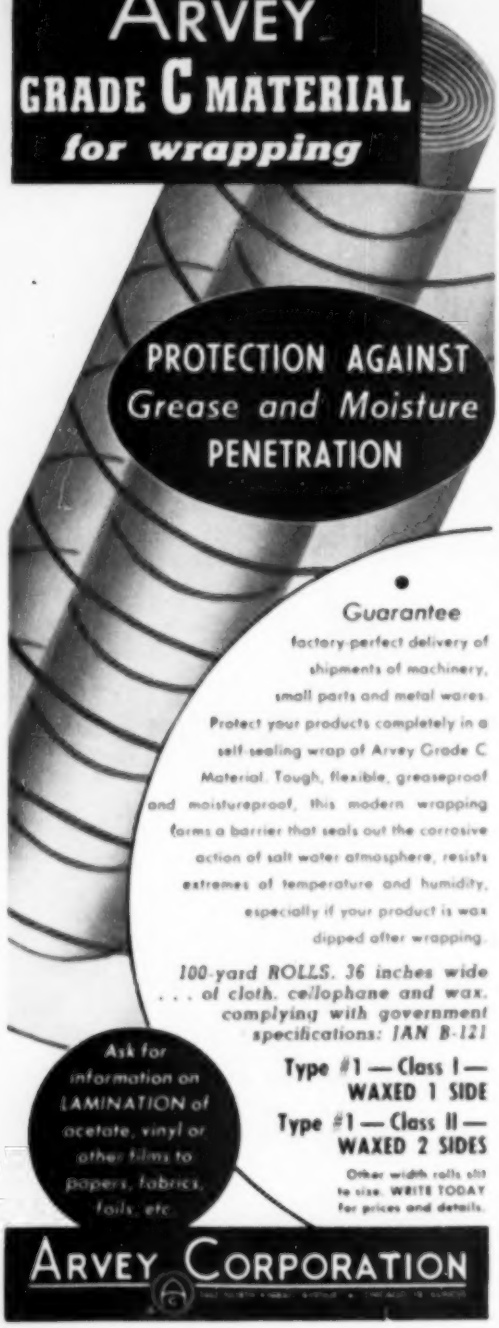

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Atomic ENERGY

NEW U-235 PRODUCTION PLANT

The Atomic Energy Commission recently announced the selection of a site for a new uranium-235 production facility. The site selected for the new plant is that of the former Kentucky Ordnance Works, sixteen miles west of Paducah, Ky., and will cover about 5,000 acres, a considerable part of which will be obtained through purchase. The new plant facilities will further expand capacity for producing uranium-235 for use in weapons or in fuel elements for nuclear reactors.

A peak construction force of 10,000 workers may be required. When completed, the new facilities will be operated for the Commission by the Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation, which operates the Commission's major production facilities at Oak Ridge. Permanent employment by Carbide and AEC upon completion of the project may be as many as 1,600 persons.

The project will be under the direction of Manager R. W. Cook of the Commission's Oak Ridge Operations Office. Mr. Cook will establish an office, to be known as the Kentucky Area Office, at the site.

Principal component of the facilities to be constructed will be a large gaseous-diffusion plant for the separation of fissionable uranium-235 from nonfissionable uranium-238. The new plant will supplement the extensive U-235 separation facilities now in operation or under construction at Oak Ridge.

The gaseous-diffusion process is one in which uranium hexafluoride in gaseous form is pumped through thousands of extremely fine barriers which have literally millions of tiny holes per square inch. Since U-235 atoms are slightly lighter and therefore travel slightly faster, they strike the screens and pass through the holes with greater frequency than do U-238 atoms. In this process, the fissionable U-235 atoms, which make up only one part in 140 of natural uranium, are gradually separated and concentrated.

Operations of the plant will involve no appreciable radiation problems. In the five years the similar Oak Ridge gaseous-diffusion plant has been in operation, not a single employee has suffered a radiation injury.

The AEC is working out arrangements with the Tennessee Valley Authority and a syndicate of five privately owned public utility firms whereby the public and private power networks would jointly supply electric power to the projected new in-

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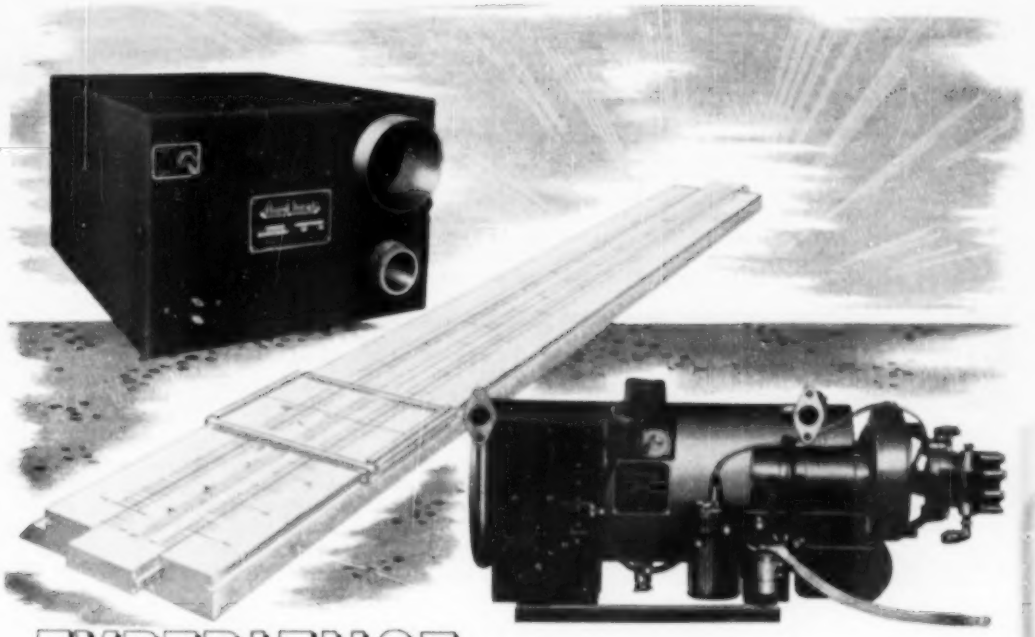

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stallation. Under tentative agreements with the TVA and the syndicate of private companies, known as Electric Energy, Inc., each would supply approximately half of the total power needs. The five companies in Electric Energy, Inc., are Central Illinois Public Service, Illinois Power Company, Kentucky Utilities Company, Middle South Utilities, Inc., and Union Electric Company of Missouri.

Under the plan adopted by the Commission, both the TVA and Electric Energy, Inc., would build new steam-generating facilities, located in such manner as to provide the maximum security and to assure the most dependable supply of power to the new AEC plant. The generating and distribution systems of both TVA and of the five private companies would be so interconnected as to provide for the use of the total power resources of all systems and to permit economic interchange of power to utilize periodic surplus power from the new generating stations.

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The Markem Machine Company is now in its 40th year of designing and building specialized *marking machines*, as well as *printing elements* and *marking inks* to go with them. Dozens of industries have depended for years on Markem machines and Markem supplies to solve their many different marking problems.

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all types of shells — These make direct imprints, eliminating troublesome and costly metal stamping, on shells of all caliber, either on cases or complete rounds, at production speeds from 700 to 7,000 an hour depending on the size of shell being marked.

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labels and tapes — All types of labels, including pressure-sensitive tapes, can also be imprinted with Markem machines. Whether the need is for shipping, inspection, or production control labels – Markem machines will help you turn them out, quickly and inexpensively, right on the premises.

All Markem machines are constructed to permit rapid changes in the data imprinted, and all use quick-drying, durable inks scientifically formulated for the purpose intended.

If you haven't yet investigated the time-saving, money-saving possibilities of Markem's many machines and supplies—then this is surely the time to do so. Write us today, giving specifications of the marking jobs required in your plant, and we'll supply estimates on the most economical equipment to do each job better.

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NEW SOURCEBOOK

The "Sourcebook on Atomic Energy," a comprehensive review of basic non-secret atomic-energy information prepared under the direction of the Technical Information Service of the U. S. Atomic Energy Commission, has recently been published by the D. Van Nostrand Company, New York City. Retail price is $2.90.

The sourcebook was written by Dr. Samuel Glasstone, scientist and author and consultant to the AEC, who also served as executive editor of the recently published "Effects of Atomic Weapons." The foreword is by Chairman Gordon Dean of the AEC.

The sourcebook project was undertaken by the AEC at the request of the American Textbook Publishers Institute which also assisted in planning the book and in reviewing the completed manuscript. The manuscript was also reviewed for technical accuracy by a number of scientists associated with the national atomic-energy program and by the AEC Office of Classification for security purposes.

The book is considered suitable for use by any one interested in the scientific and technical aspects of atomic energy, including college students, teachers, and textbook authors.

SOUTH AFRICAN URANIUM

Uranium to be produced in the Union of South Africa as a by-product of gold production will be sold to the United States and the United Kingdom under an agreement recently concluded by the three nations.

The new agreement marks the successful culmination of several years of intensive research and development by these nations on the problem of economically recovering uranium from the gold-bearing ores. The South African gold ores represent one of the world's largest sources of uranium. Although the uranium content of the ores is small, potential production is relatively large because of the great quantities of ore mined.

Funds to cover the capital cost of the uranium-processing plants will be loaned by the United States and United Kingdom, on a banking basis, if requested by the South Africans.

Although uranium will be a valuable by-product of gold production, the revenue and earnings from uranium will not be on such a scale as to affect materially the financial positions of the companies concerned.

Plant design and construction leading to the production of uranium under the new agreement is proceeding on an urgent basis. Because of security considerations, no information on rate of progress or other aspects of the program can be made public.

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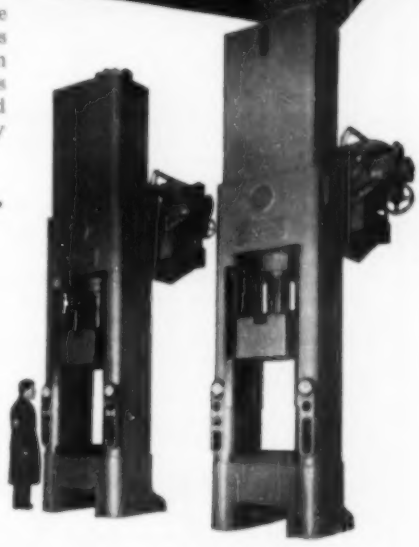

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MAGNETIC IRON OXIDE—For thermit mixtures used in incendiary bombs and other applications.

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FROM THE RECORD

TANK PROCUREMENT

Until very recently there had been no tanks made for the United States Army since World War II. We had designed new ones, we needed them, and we asked for them; but the economy, it was felt, could not provide new tanks at that time. Now we know that we have to have new tanks. So what do we have to do?

First of all we have to put a cut-off date of some kind on our research and development which is always moving ahead and finding improvements in our designs. We have to decide arbitrarily when we have reached sufficiently close to perfection. This requires the best possible intelligence as to what the enemy has, because we have to know what his guns and armor are in order that our guns and armor may be right.

Then we have to have prototypes made —and that takes a long time because of the new tooling required and the production kinks that have to be ironed out. When these tank prototypes are finally completed they have to be field-tested and put through all sorts of performance checks.

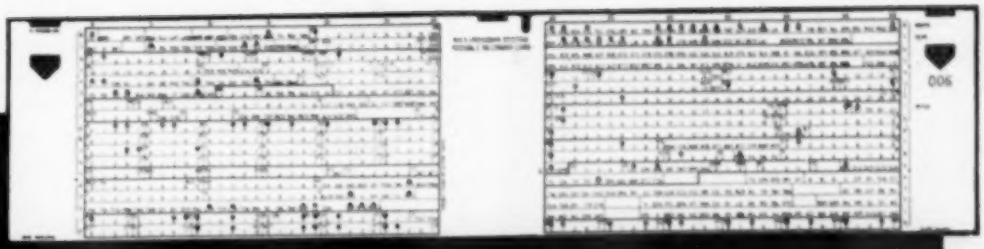
Finally, when we have frozen a model, we have to find out where we are going to get it made.

Here we have the problem of gearing production contracts in with what would happen in case war breaks out. We don't want to start making tanks in peacetime in Plant A when we know the contract would have to placed with Plant B in case war breaks out. Besides which, we don't want to make tanks in any plant which would conflict with Navy or Air Force requirements. So all that has to be geared in.

On the other hand we don't want to go to one big automotive manufacturer in this semimobilization period and say to him, "Wouldn't you like to make tanks for us and stop making civilian automobiles?"

If we force him to do that we are being very unfair. We have to try to treat all the people in the automotive field in the same way so as not to put any one at a disadvantage with his competitors.

All those factors have to be considered on just one type of weapon—the tank—and we have hundreds of major items of equipment which are similarly complicated from the standpoint of procurement and long-range planning.—SECRETARY OF THE ARMY FRANK PACE, JR., *before the Economic Club of New York at the Hotel Astor, New York City.*



Another reason why your telephone gives so much for so little

Studying punched card record of dial system operation. Each card (top) can report 1080 items

In a large, modern dial telephone office, 2,000,000 switch contacts await the orders of your dial—and 10,000 of them may be needed to clear a path for your voice when you make a single telephone call. Within this maze of signal paths, faults—though infrequent—must be detected and fixed before they can impair telephone service.

The latest system developed by Bell Telephone Laboratories automatically detects its own faults, detours calls around them without delay—then makes out a "written" report on what happened.

The fault may be a broken wire, or a high resistance caused by specks of dirt on switch contacts. In one second, the trouble recorder punches out a card, noting in detail the circuits involved and the stage in the switching operation where the fault appeared.

Maintenance men examine the reports at intervals and learn what needs attention. Between times they go about their own duties in keeping service moving.

This is another example of how research at Bell Laboratories helps your telephone system operate at top efficiency, so the cost to you stays low.

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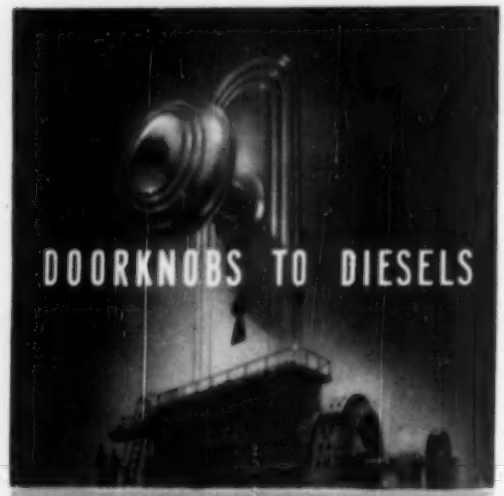

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LIEUT. COL. JOHN J. DRISCOLL, *author, air armament engineer, air combat officer, Headquarters, United States Air Force, Washington, D. C.*

Air Power: Key to Survival. By Alexander P. de Seversky. New York: Simon & Schuster. 376 pp. $3.50.

JUST after the outbreak of World War II in Europe, Major de Seversky, in his earlier work "Victory through Air Power," stressed the urgency for the kind of air power that eventually played a decisive role in achieving victory. His new document, "Air Power: Key to Survival," written just prior to the onset of the Korean campaign, is similarly one of great importance to the American public.

The basic theme of the book is that we have no alternative but to by-pass Russian ground forces through the skies. The author stresses that we must stop the habit of dividing our defense appropriation into roughly three equal parts—that the decisive air weapon should receive at least two-thirds of our national defense effort. It is interesting to note that despite his strong support of interhemispheric warfare, he plays down the importance of the A-bomb as a weapon given "pseudoscientific trimmings and exaggerations and imaginative assumptions."

The prologue, "Lesson of Korea," is particularly timely. Major de Seversky clearly defines the abnormal pattern of the campaign which is being dictated and controlled by Stalin. The

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Book Reviews

author foresaw the events of the past few weeks with Moscow holding the complete initiative. He warns against our making two fatal mistakes: Of grinding out weapons for a titanic overseas surface war on Russian terms and of pouring endless numbers of men and machines into the bottomless well of Korea.

It is certain that this book will arouse much controversy. Many may disagree with one or another of the author's precepts. Nevertheless, in view of his background and past record, the analyses of De Seversky deserve the earnest consideration of all Americans.—JOHN J. DRISCOLL

Strategic Intelligence for American World Policy. By Sherman Kent. Princeton: Princeton University Press. 226 pp. $3.

STRATEGIC intelligence is, according to Professor Kent, "the knowledge vital to national survival." The tremendous importance of the subject, its complexity and its immensity, will be appreciated by almost all readers of this work. Perhaps that realization is its greatest contribution to the layman.

The subject is so vast, so many-sided, and, alas, so new to us in America, that to attempt to cover it all in one small volume is difficult, maybe impossible. That the author should become bogged down in so many ramifications seems obvious. It is quite possible that a simplified book for the layman and another, more technical in character, for the professional, would have been a better answer to the problem.

Dr. Kent's six years in intelligence work give him a splendid background, but it appears that the basic difficulties have not been met. The author's understanding of the military side of intelligence is far from profound, and there is still very great difference of opinion among professional intelligence workers. The volume is certainly a real approach to its subject, however, and is to be commended as such.—F. W. FOSTER GLEASON

Atomic Attack—A Manual for Survival. By John L. Balderston, Jr., and Gordon W. Hewes. Culver City: Murray & Gee, Inc. 55 pp. $1.

THIS book is a practical manual for Civil Defense organizations and others connected with disaster committees. It is also a "what-to-do book" for the average citizen.

Defense against the atomic bomb is not hopeless but only more complicated than defense against the old-fashioned TNT and fire bombs. You must act more quickly. But if you know what to expect and what to do, you may come through unharmed even while your neighbors die. If, that is, you think fast in that split second when your life is at stake.

When an atom bomb strikes, there will be disaster. The authors advise us to think and plan now in order to increase our chances of survival. It is possible, they say, to protect at least one room in your home against the effects of the bomb. It is even possible to guard against lethal radiation.

The first part of the manual tells you what to do—now. The second part gives the reasons why. This very practical handbook will interest all citizens who take the atomic bomb seriously.—JOHN J. O'CONNOR

Center Fire American and British Pistol and Revolver Cartridges. By Henry P. White and Burton D. Munhall. Washington: The Combat Forces Press. 143 pp. $7.50.

VOLUME II of Cartridge Identification is uniform in size (8½ x 11½ inches) with "Center Fire Metric Pistol and Revolver Cartridges," reviewed in the May-June 1949 issue of ORDNANCE. The two authors continue the monumental task of compiling a unique and complete list of the thousands of different handgun loads and their very exact dimensions, markings, characteristics, and the guns from which they may be fired.

Few avenues of research have been left untapped to produce a series of volumes (more are to appear) which will provide police, courts, collectors, and gunbugs with an unequaled source of information. The pair of authorities whose labors have produced this unique work operate the only independent ordnance engineering firm in America. So their writing has paralleled their work, and it would appear that only such a combination could ever make such a compilation economically feasible.

Some 250 drawings, silhouettes, and photographs, each accompanied by meticulous measurements and explanation, comprise the body of the book. Appendices, including sixteen pages of conversion tables, such as grams to grains and millimeters to inches, round out the work. The inclusion of a few Continental cartridges seems incongruous with the title of the volume but is surely a tiny and immaterial fault in such a splendid piece of ordnance study.—F. W. FOSTER GLEASON

The Development of Tactical Services in the Army Air Forces. By John M. Coleman. New York: Columbia University Press. 298 pp. $4.

IN view of the present large-scale defense reactivation, here is a most timely book for use as a training text or for reference reading. The author had access to documents and records that were

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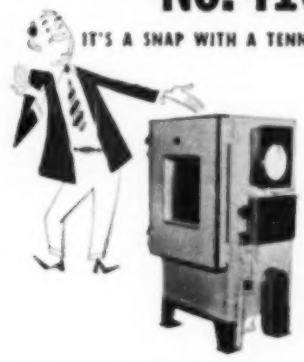

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MIL-S-5002	"Aladine"
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JAN-C-490, Grade 1	"Granodine" Dip, Spray and Brush grades
JAN-P-495	"Granodine" Dip, Spray and Brush grades
	"Lithoform"
JAN-L-548	"Permadine"
AN-E-19	"Aladine"
	"Zinodine"
AN-P-20	"Aladine"
	"Granodine" Dip, Spray and Brush grades
	"Lithoform"
	"Permadine"
	"Thermail Granodine"
	"Zinodine"
	(See also U.S.A. 3-213
U.S.A. 57-0-2	
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Type II, Class B	"Permadine"
Type II, Class C	"Granodine" Dip, Spray and Brush grades
U.S.A. 51-70-1	
Finish 22-02, Class A	"Thermail Granodine"
Finish 22-02, Class B	"Permadine"
Finish 22-02, Class C	"Granodine" Dip, Spray and Brush grades
U.S.A. 30-60-1	"Granodine" Dip, Spray and Brush grades
U.S. Navord O.S.675	"Aladine"
U.S.N. Appendix 6	"Lithoform"
Navy Aeronautical M-364	"Permadine"
	"Thermail Granodine"
AN-C-170	(See MIL-C-5541
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Type 5	"Deoxidine" Nos. 170, 171, 670
U.S.A. 3-213	
Type I	"Deoxidine" (Wash-off grades)
Type II	"Deoxidine" (Wipe-off grades)

Metal Cleaning Chemicals

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JAN-C-490, Grade II	
Type 2	"Ridoline"
Type 6	"Ridosol"
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U.S.N. Appendix 6	"Deoxidine"

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Write us for descriptive folders and further information on the specification chemicals listed above. Additional copies of this chart are available on request.

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secret or confidential during the war, and he thus makes available for the first time much information on the difficulties of organizing an efficient supply and maintenance service for a rapidly expanding Air Force operating on a world-wide scale.

The background history given in the first chapter shows clearly the reasons why we found ourselves enmeshed in a war with neither an adequate air arm nor the trained personnel to build one. However, from the first group of twelve B-17's flown to Java to take part in the early fighting we learned quickly the need of service forces, and the story of the organization of training units, supply and maintenance groups, down to the efficient floating maintenance workshops that operated among the Pacific islands, is told in progressive order.

The book covers intricate technical and tactical problems, but it is no dry technical wilderness. The author has expressed an ability to write about these matters in an understandable manner that makes relatively easy reading.—GEORGE S. BRADY.

American Antique Guns and Their Current Prices. By Martin Rywell. Harriman, Tenn.: Pioneer Press. 40 pp. $1.

AN enthusiast and authority on old arms and their collection here catalogs U.S. pistols and revolvers (flintlock through automatic) together with the average price of each type and model. The handbook, a paper-bound and much-condensed work, serves an entirely different purpose from the high-priced, overstuffed compendiums so familiar to the collector and student of arms.

Fascinating to any one who has even a general interest in old guns (just watch the crowds at any gun shop window), of value to the professional and the habitué, its unique appeal is to the man who even considers buying an old gun or two. And that old piece you own—it might bring a couple of hundred! A directory of antique gun dealers, listings of organizations, books, museums, and the like round out a little work of interest and value.—F. W. FOSTER GLEASON.

Brave Company. By Guthrie Williams. New York: G. P. Putnam's Sons. 246 pp. $3.

HOW does it feel to be a common soldier of infantry in combat against the Germans in Italy? What is it really like in the P.B.I. (poor bloody infantry)?

The author takes you rather close to the battleground and to the day-by-day existence of an infantry rifle squad. The reader finds himself in an Australian sec-

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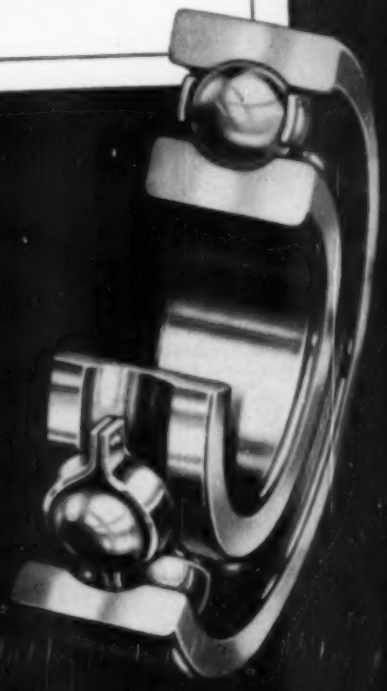

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Book Reviews

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In many aspects this is a Second World War version of Remarque's classic "All Quiet on the Western Front." At times there is a striking resemblance, but "Brave Company" is perhaps too involved with a complex analysis of individual psychological reactions and emotions. It lacks the beautiful simplicity and directness of Remarque's work.

In a few places the story drags. But the opening and closing chapters alone are worth the price of admission, as are several scenes in the Italian mountain war and a prolonged attack near Cassino.—MELVIN M. JOHNSON, JR.

Pocket Encyclopedia of Atomic Energy. By Frank Gaynor. New York: The Philosophical Library. 204 pp. $7.50.

FIRST editions of encyclopedias are usually incomplete and of faulty arrangement, and this volume does not escape the criticism, although it should be useful to any one wishing quick reference descriptions in the field of atomic energy and nuclear physics. The "pocket" label, however, is a misnomer, as the book is of standard desk size.

Much of the content consists of standard terms whose definitions can be found in any chemical or physical dictionary, and there is too much diffusion in indexing.

When one considers that many lines are taken up with listing simple chemical symbols in addition to an equal number of descriptions of the elements, that much space is devoted to descriptions of ordinary terms, such as density and foot-pound, and that there is a constant repetition of abbreviations which users would normally look up under the full name, it is seen that the publisher's statement of "over two thousand entries" boils down to a few hundred at most.—GEORGE S. BRADY.

Principles of Aircraft Propulsion Machinery. By Israel Katz. New York: Pitman Publishing Company. 477 pp. $6.50.

THIS is a very general treatment of the subject, but it probably is meant to be more of a reference volume than a detailed text. When used as reference material it is a valuable addition to any one's library. However it is not always sufficiently complete in its treatment of subjects such as ignition, spark plugs, carburetion, fuel injection, and so forth, to meet reference needs. The bibliography is fairly complete, and as a whole the book makes good reading for a person who has close contact with the aircraft-propulsion industry.—PHILIP SCHWARTZ.

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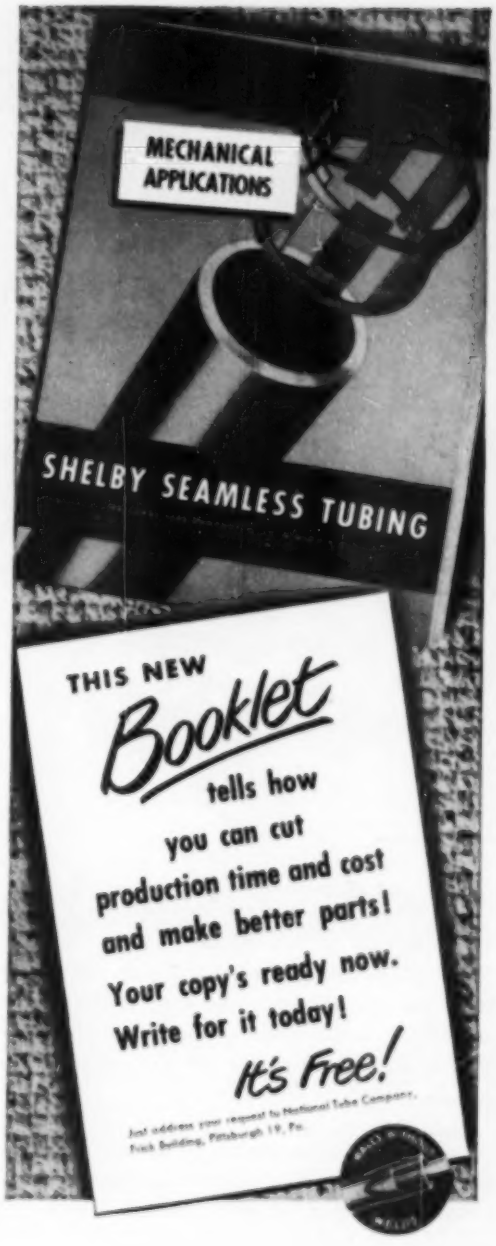

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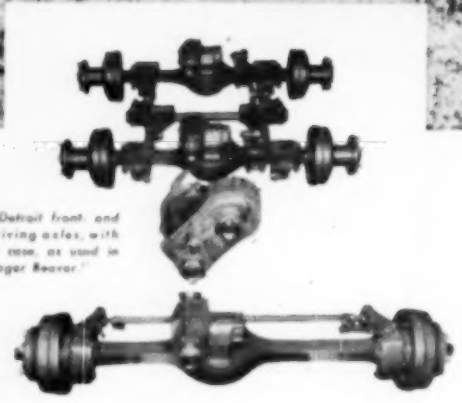

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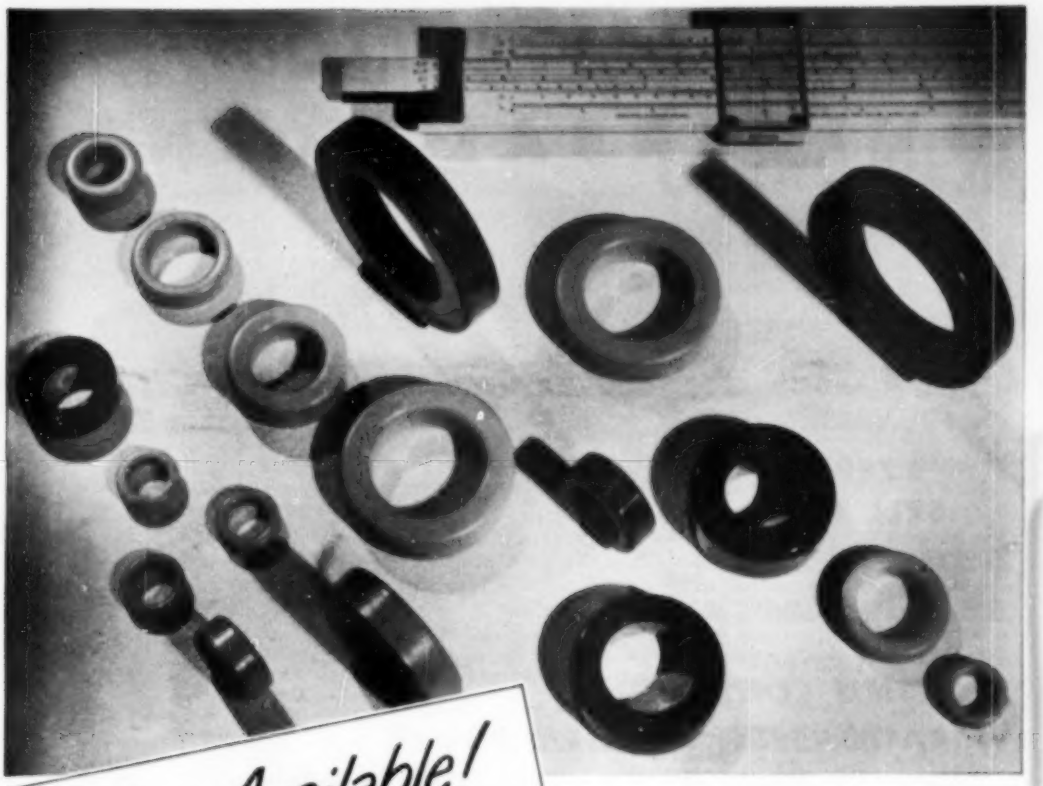

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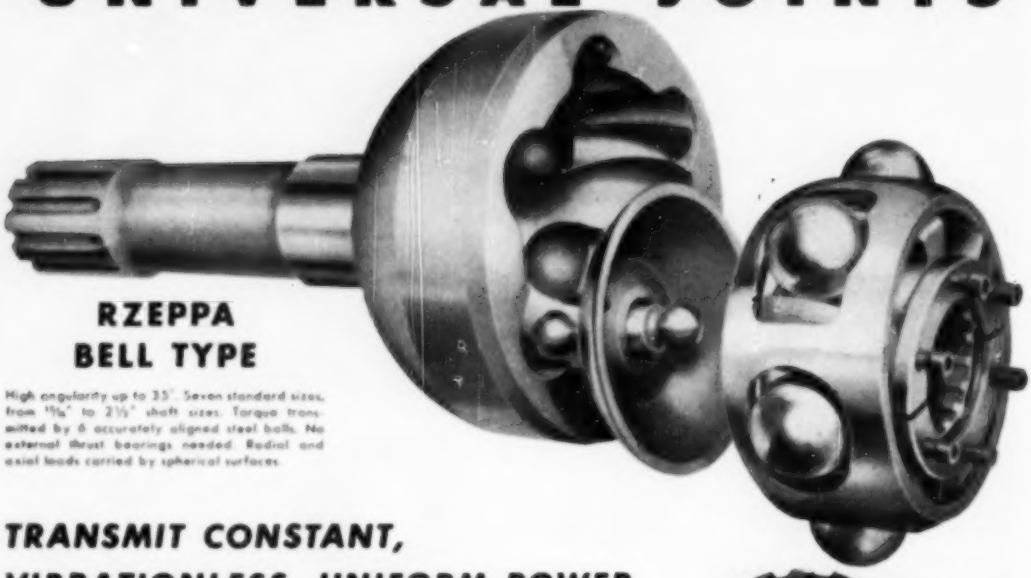

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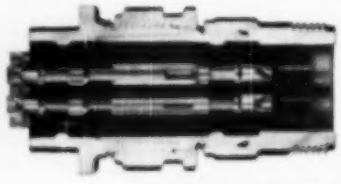

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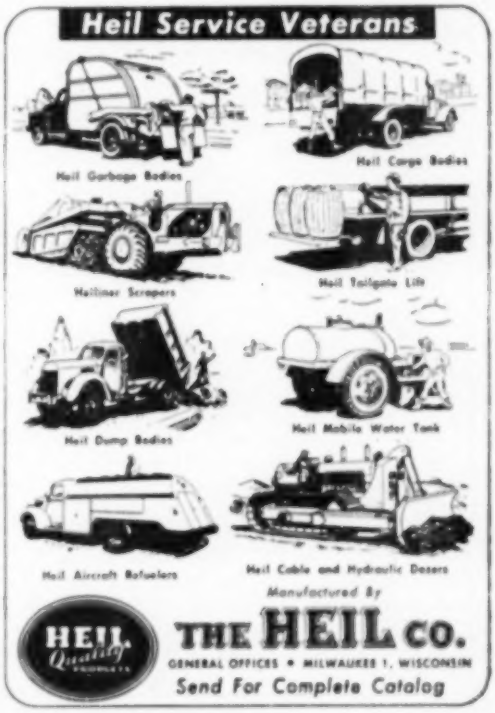

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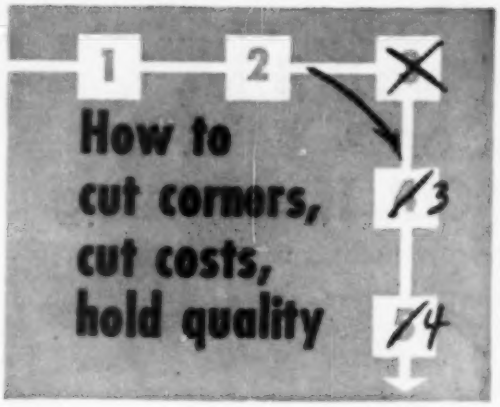

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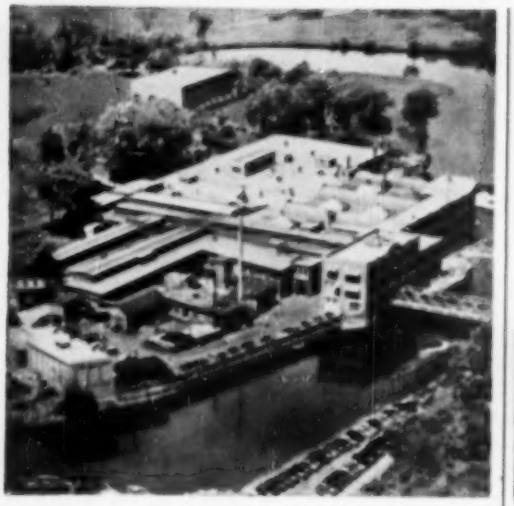

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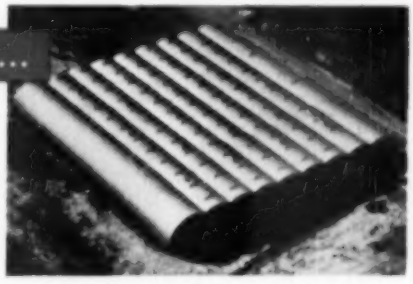

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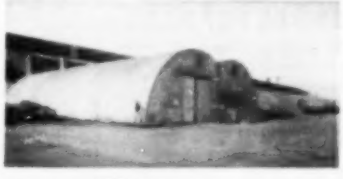

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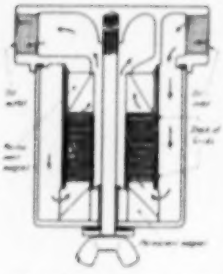

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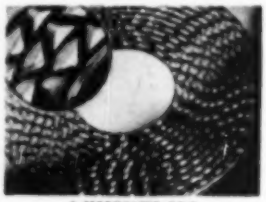

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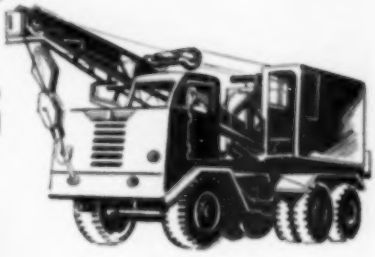

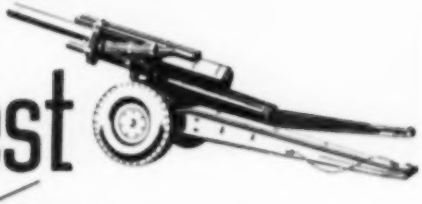

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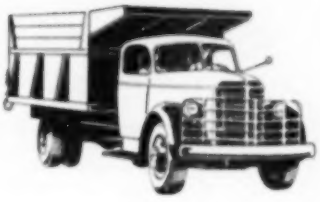

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These low-alloy, high-tensile steels do "make a ton of sheet steel go farther"—for their inherently higher strength is 50% greater than mild carbon steel. That means, in turn, that 25% less section can be used with safety, and where rigidity is important, this can usually be compensated for through slight design change.

"Make your product last longer" is no idle claim. The much greater resistance of N-A-X HIGH-TENSILE to corrosion, abrasion, and fatigue assures longer lasting products even at reduced thickness.

Explore the potential economies to be derived from the use of low-alloy, high-strength steels—and then specify them. Their use can add materially to our national conservation program.

GREAT LAKES STEEL CORPORATION

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, and related subjects.

The Metal of Tomorrow

Titanium - A Dream and a Nightmare For Lightweight Military Equipment

Col. Benjamin S. Mesick

Chief, Research and Material Branch, Army Ordnance Research and Development Division

RECENT world events have pointed out the need for transportability of a high order in today's and tomorrow's military equipment. The newspapers have made it quite apparent that airborne equipment was of great importance to us in Korea and, by inference, that such equipment will continue to be of importance in the foreseeable future.

In meeting a carefully planned attack or in launching an offensive, heavy equipment in sufficient amounts must be deployed in a minimum of time. The feasibility of air transportation of heavy equipment such as tanks and artillery has been demonstrated. The time element is even more important than mere feasibility of transport—how much can be transported in how long, and what transportation facilities are available?

As of now, certain models of artillery and of tanks can be transported by air, but how many of these models can be carried by one airplane? Army Ordnance today is very conscious of this question as well as one of corollary importance which was inferred in the words of Gen. Omar N. Bradley in a recent article for *Reader's Digest* and *Combat Forces Journal*: "We have not gone nearly far enough in making the infantryman's load lighter. To save himself in order to win the battle, the G.I. must be the best-equipped, the best-protected soldier, and the soldier with the lightest load."

The corollary problem is how to give the foot soldier heavier firepower and at the same time decrease the load he must lug over rugged terrain. If we could do this we would not only increase the effectiveness of our foot soldiers but would decrease the number of casualties because he would be capable of outranging his foe.

Redesign Equipment

An obvious answer is to modify existing equipment by redesign or to use lighter but stronger materials. If this can be done, more items of equipment can be transported per airplane, and heavier caliber equipment can be manhandled instead of requiring motive power. In the case of equipment to be used exclusively on the ground, the weight saving can be used for greater mobility, longer operational range, added protection on armored vehicles or to put armor on equipment which is not so protected. This development of lighter equipment is a constant project which has brought forth accomplished results such as recoilless artillery.

A second way in which to lighten equipment is to use a material or metal which is lighter and has sufficient toughness, strength, and other essential physical properties. Of the structural materials available, aluminum, magnesium, steel, and a comparative newcomer—titanium—are considered in this discussion. For comparison, approximate data of some of the properties of these metals are shown in the table on page 352.

A study of this table high lights the facts that: (1) alloys of *Ti* are now available which have a yield strength on a comparable weight basis of at least

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The Machine Tool Reserve 358
Lieut. Col. D. E. Brookfield
Vital defense necessity

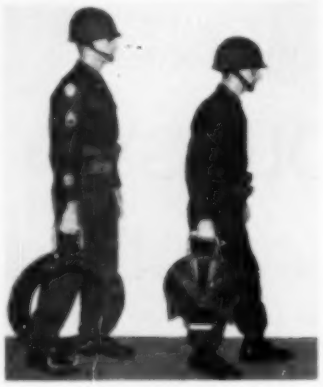
1½ times that of large production steel alloys in the fully heat treated condition; (2) the Charpy values of titanium alloys are on the high side of the range of the metals considered (this indicates toughness to a fairly high degree); and (3) the elongation values of titanium alloys are moderately good.

While elongation values are not of great importance in structural applications other than as an indicator of nonbrittleness, they are important in other applications where energy absorption is desired, because elongation when properly coupled with strength is an indication of the work absorbed in deformation.

A brief summary of the properties of titanium is necessary before discussing applications since properties often determine applications. The corrosion resistance of titanium at ordinary temperatures is comparable to stainless steel; indeed it is, in certain specific applications, somewhat comparable to platinum and is more resistant to sea water than is stainless steel.

At elevated temperatures (above 1,500 degrees Fahrenheit) the surface of the metal absorbs oxygen and nitrogen causing surface hardening; if this is found to be controllable in practice (as now indicated) it will afford a means of local surface hardening of use in many applications. Below this temperature the metal is unaffected by air and has a useful creep strength up to 1,000 degrees Fahrenheit at present. Titanium alloys appear, from preliminary tests, to retain these properties.

The metal and its alloys appear to be weldable by suitable processes such as resistance, flash, and inert-gas arc welding, although welding of heavy sections has yet to be developed; and they are quite easily forged or otherwise hot-worked or formed. The metal can be cold-worked to a considerable degree with the usual increase in strength, and its alloys appear to behave in a similar manner.



The steel base plate for the 81-mm. mortar weighs 48 pounds and is carried in two separate loads.

A titanium base plate for the same weapon weighs only 24 pounds and is handled easily by one man.

Better Characteristics

Research and development work now in progress leads one to expect certain alloys to have better specific properties: higher strength at room or elevated temperatures, better impact characteristics, higher fatigue limits, etc.

Of the metals under consideration, titanium possesses nearly all the desirable properties to some degree. In addition, it is believed to be the ninth most common element and the fourth most common metal, being more plentiful than copper, nickel, or lead. Titania is used in large quantities as a common paint pigment.

Ore deposits occur sufficiently concentrated within the United States and North America to assure the economic production of titanium and our independence of overseas sources. Its present price of more than $5 a pound conceivably can be lowered to a figure comparable to that of high-quality alloy steel. Would you expect to find a metal with such characteristics other than in a dream?

The "nightmare" aspect of titanium and its alloys could be summed up in one statement: The metal and its alloys are violently reactive in the molten state. However this deserves amplification because the specific behavior of titanium in the molten state may well play a large part in controlling applications. Its reactivity will require the development of new techniques if titanium is to be commercially practical.

The "nightmare" properties include, first, a high melting temperature of approximately 3,150 degrees Fahrenheit; and, secondly, the fact that when molten it reacts with the gases of air to form the nitride and the oxide so rapidly that their presence is intolerable. It reacts with CO, CO_2, and possibly water vapor. It reacts with hydrogen to form the hydride. This imposes the restriction that when molten it must be under conditions of extreme vacuum

Material	Yield Strength (psi)	Elongation (%)	Charpy Impact (ft.-lbs.)	Density (lbs. in.$^{-3}$)	Yield Strength of Equiv. Wt. Sect. (*)
Pure *Ti* (Iodide)	18,000	55	15	0.16	31,500
Commercially pure *Ti***	75,000	15	15	0.16	131,000
One available *Ti* alloy	155,000	10	20	0.16	271,000
Typical *Al* alloy	45,000	20	7	0.10	125,000
Typical steel alloy***	175,000	15	15	0.28	175,000
Typical *Mg* alloy	30,000	5	5	0.065	127,000

**The yield strength in pounds for a cross section whose weight is equal to one square inch of steel of the same length. The yield value is used as it has more influence on engineering use or application than the usually quoted ultimate tensile strength.*

***So-called "commercially pure titanium" is an alloy of varying composition (depending on process) containing, in addition to Ti, amounts of nitrogen, oxygen, carbon, etc., which significantly affect physical properties. At present the term has no more significance than would "commercially pure steel" in speaking of ferrous alloys.*

****A moderately alloyed heat-treated steel available in large sections.*

Comparative property data on various structural metals.

or in an atmosphere of properly prepared inert gases such as argon or helium.

Thirdly, it reacts to a varying but rather prohibitive degree with all known refractory materials such as alumina, magnesia, silica, and carbonaceous materials. This last property poses the questions of what available material to use in the melting furnaces and what molding material for casting.

Titanium is an "ornery critter" that reacts when molten with virtually everything it touches, and for this reason it requires a whole new concept of commercial melting, ingoting, and casting practice. A common-sense approach along this line has already yielded some results and, we have cause to believe, will solve the problems presented by titanium's "nightmare" properties.

The specific applications of titanium and its alloys in military equipment can be indicated for the most part only in a general manner. The basis of its use is its strength, lightness, corrosion resistance, and, inversely, its price. At its present price today's uses will be limited to items where lightness and strength are not only highly desirable but of paramount importance. Where titanium is substituted for steel alloys, size for size, a weight saving of roughly forty per cent results. As its price decreases with increased supply, its applications will snowball to include its use in many commonplace items to replace materials such as aluminum, magnesium, and steel.

In view of the facts discussed above and the present status of titanium development, a large amount of Army Ordnance effort today is directed toward a more thorough determination of the specific properties of titanium alloys. This encourages the development of practical techniques for the production of large ingots and finished castings and for the welding of sheet and of thick plate (greater than three inches).

Only when the property data are available can a comprehensive application program be executed without a hit-or-miss attack; and when the techniques are available the large demand applications become a probability.

Priority to Titanium

Army Ordnance is giving first priority to the use of titanium today in the lighter-type applications wherein manhandling is involved. A typical case is pointed up by the 81-mm. mortar base plate now undergoing service tests which indicate that the much lighter titanium is a satisfactory substitute for steel.

The standard steel base plate of the weapon was of necessity made in two pieces so that each part could be carried by one man. The balance of the weapon is carried by a third man. Each base-plate component weighed approximately twenty-four pounds, a desirable one-man load.

By substituting "commercially pure" titanium (actually an alloy) for steel in the base plate it became possible to make the whole base plate in one piece of welded construction weighing about twenty-four pounds. The accompanying photographs illustrate these facts. Now only two men instead of three are needed to carry the 81-mm. mortar, in essence effectively increasing the firepower per man and still using a heavy-caliber weapon. This priority group includes other weapons wherein lightness is of paramount importance.

Preliminary tests on low-alloy titanium do not indicate satisfactory erosion resistance to hot gases of extreme velocity which may limit the applications having this requirement limitation. This may be only temporary, for improved alloys may be developed which will have satisfactory erosion resistance.

Another application involving smaller pieces which are obtainable today would be in certain types of missiles wherein mass is not essential to the damage effect but where the decrease in weight would increase range more than proportionally to the weight reduction.

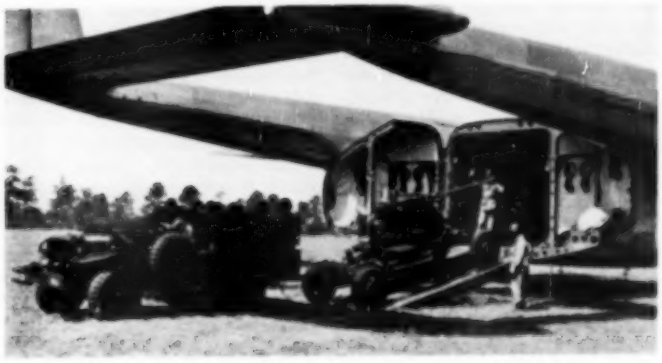
Although the individual parts would be small in size, such applications would require the expenditure of considerable quantities of metal. For these applications, light-gauge sheet and plate and small forgings and extrusions will serve to lighten existing man-carried weapons and ammunition and will constitute the chief use of titanium alloys in modern armament.

For the armament of tomorrow, Army Ordnance is contemplating the use of large and thick sections of titanium to increase the transportability of large-caliber weapons. In addition, the possible application to heavy armor is self-evident. It is conceivable that titanium alloy can eventually be substituted thickness for thickness for alloy steel armor, reducing armor weight by about forty per cent.

Use in Structural Members

A study of available information indicates that the use of titanium alloy for structural members and suspensions of combat vehicles is justified by the increased mobility and transportability. Trials of such applications await the development of the fabricating techniques already mentioned.

It is estimated that the judicious substitution of titanium alloy in certain armored vehicles would reduce their gross weight by a minimum of twenty-five per cent. This weight reduction is of paramount importance for air transportability and highly desirable from a mobility standpoint.



A Fairchild C-119 Packet delivers a ¾-ton truck, a 40-mm. antiaircraft gun and crew totaling 15,000 pounds. Titanium could appreciably lighten this load.

It is self-evident, moreover, that the new material can be used advantageously in artillery to increase its over-all air transportability as well as to increase its mobility in the field under adverse combat conditions. Lightening of such components as carriages, wheels, platforms, armor shields, and possibly the gun tube itself are in the realm of possibility.

In some cases where such weight savings have been achieved, mobility may be sacrificed for the addition of shields or protective armor where protection is not now afforded.

Weight Redistribution

Another prospective use of titanium is in the redistribution of weight through its use in certain components of existing equipment. These applications will make possible flexibility of employment of such equipment considerably beyond present limitations.

The Corps of Engineers would like to use substantial amounts of titanium for military bridging and landing mats where transportability and manhandling are of prime desirability, as in the case of replacement of bridges during combat. This and other desirable uses await only price reduction and availability. The other technical services, especially the Transportation Corps, Signal Corps, and Chemical Corps, have in mind specific applications of titanium or its alloys. As an indication of the fact that this new material has passed the laboratory stage, it is estimated that the Army alone will use for research and development purposes approximately 550,000 pounds during the next 18 to 24 months.

The Air Force and the Navy Bureau of Aeronautics and the Bureau of Ships have been considering the use of titanium and its alloys for several years. As might be expected, airmen are further along than the land forces in applications and requirements because they are extremely conscious of weight saving. Both air services plan on substituting titanium and its alloys quite widely in place of both aluminum and stainless steel. They have started in the same manner as the Army is beginning —by substitutions which involve small pieces such as forgings, extrusions, and sheet of sizable dimensions.

For applications in and adjacent to various engines where temperatures do not surpass 800 degrees Fahrenheit, titanium alloy sheet may be substituted, gauge for gauge, for stainless steel. These applications would include such items as aircraft firewalls (an ideal substitution because of titanium's high melting point), hot-air ducting, bulkheads, outer combustion chambers, shrouding, and leading edges of wings. Small forgings are to be used for brackets and fittings in and around engines. Other applications in the planning stage are for pilot oxygen equipment and cabin-cooling compressors.

The Navy Bureau of Aeronautics is not only interested in weight-saving possibilities but also that added feature —corrosion resistance to salt water and sea air. This fact makes titanium of interest to the Bureau of Ships and other sections of the Navy. They are watching Bureau of Aeronautics developments quite closely, as their major applications are somewhat controlled by price.

As an indication that titanium has passed the laboratory stage, it is estimated that the Army alone will use for research and development purposes approximately 550,000 pounds during the next 18 to 24 months.

A recent study has indicated that a weight saving of over a thousand pounds can be achieved by direct substitution of titanium alloy, where feasible, for stainless steel (gauge for gauge) in and around large engines. Thus, in large aircraft, by considering all reasonable applications of titanium the gross weight can be reduced by approximately five tons. Such a weight saving is almost priceless. Is there any wonder why the Air Force is so interested in volume production of titanium even at today's prices?

Heavy Requirement

The foregoing applications are not conjectural—they are here *today*, and they will require millions of pounds of titanium during the coming year. This demands awaits only supply. Price is not a determining factor, for the elimination of a pound of aircraft weight is a precious thing to airmen.

Further aircraft applications with tomorrow's availability are envisioned in more massive applications—for aircraft landing gear, combat field landing mats, possibly propeller blades, and highly stressed applications where alloy steels are used at present. Obviously some applications, where the low density and high strength of this new material will be used to reduce dynamic forces, await further development of titanium alloys.

Vigorous Support Needed

Considering the many attractive application probabilities is it any wonder that titanium has been given so much technical and general publicity in this country? The impetus probably has carried to other countries engaged in the production of military equipment. It is of extreme importance therefore that our titanium development program be adequately supported and be carried out with great vigor.

In closing, it is appropriate to mention the major problem which we face in large-scale utilization of titanium—how can sufficient quantities be made available and at a more reasonable price? The latter factor is corollary to the former and of somewhat less importance.

In our economy it has been almost axiomatic in the past to expect unaided industry to deliver the raw-material requirements of the Nation. This means large capital outlays which industry may be reluctant to make in the case of a new material where change may occur rapidly due to the development of new processes.

Lack of Facilities

On the other hand, the incentive of sizable orders is retarded only by the lack of production facilities. The problem resolves itself into a matter of vision and faith. Industry should find within itself sufficient faith in the future of titanium to be bold.

The properties of titanium indicate that it is not only of interest to the Department of Defense but is "the Metal of Tomorrow." In our American system the reward is for risk. Considering titanium's future, is there a risk?

(The author wishes to acknowledge the cooperation of the Air Force and the Navy Bureau of Aeronautics in the preparation of this article.)

Ammunition Supply Overseas

The Army Has a New, Simplified, and Realistic System

Lieut. Col. John W. Schroder

Picatinny Arsenal, Dover, N. J.

The new method standardizes terminology, reduces the number of reports required, and insures adequate supply to the troops

MEN may fight for a while with empty stomachs but not with empty guns, for an adequate supply of ammunition is essential to the success of any combat operation. Not only must ammunition be available, but it must be the exact item of ammunition needed. The problem of ammunition supply is further complicated by the large tonnages involved. For example, the basic load of ammunition carried by an infantry division is in excess of 1,300 tons. That same division may use as much as 600 tons of ammunition in a single day of combat.

Heavy Tonnage

The effect of this tonnage on the over-all transportation system may be visualized if it is realized that twenty per cent of all tonnage of supplies entering a theater of operations is ammunition. Due to the distribution of consumption, as shown in Figure 1, ninety-five per cent of the ammunition, contrasted with twenty-two per cent of all other supplies, must be shipped as far forward as the division areas.

Because of the importance of having the exact item available and because of the large tonnages involved, it is essential that ammunition supply be closely controlled. In the past this need for control has led to cumbersome credit and report systems which were particularly annoying at lower echelons.

Since World War II, the Department of the Army has adopted a simplified system for ammunition supply in an overseas theater. This system, which is now covered in detail in Special Regulations No. 700-310-1, dated January 16, 1950, has as its purpose the simplification of ammunition supply at all levels by placing it on a realistic basis, standardizing terminology, and reducing the number of administrative reports required.

Historical Background

A consideration of the historical background of the ammunition supply system will assist in understanding the new system and the reason for some of its provisions. During World War II the term "unit of fire" was used to designate ammunition stock levels and credits against this ammunition.

While using troops and Ordnance ammunition officers had to deal with actual number of rounds of each type of ammunition, the term "unit of fire" was a convenient package with which the General Staff officer and commander could deal. The very nature of this package and its ease of use made it unsatisfactory for control of ammunition in wartime. One disadvantage was the fact that telling a commander that he had two units of fire available did not tell him how many days of fighting it would provide. The length of combat two units of fire would support varied with the weapon and the nature of combat anticipated.

Ratio Not Constant

To further confuse the situation, the ratio of the various types of ammunition required during different types of combat is not constant.

A second disadvantage was the fact that the use of the term "unit of fire" to designate required stocks for a force often resulted in unbalanced stocks or unreasonable demands. An interesting instance of this developed in the Southwest Pacific in 1944 when the Sixth Army Headquarters directed its units to take ten units of fire for antiaircraft weapons in a planned operation.

When the requirements for this ammunition reached the ammunition supply officer at Army Services of Supply headquarters it was discovered that, for one caliber of ammunition, the total requirements for the forces involved in this operation exceeded the total quantity of that caliber authorized by the War Department for use in the entire Southwest Pacific Theater.

Again, the use of the unit of fire as a basis for shipment of ammunition to Sicily resulted in a surplus of 8,000 tons of small-arms ammunition on that island—a quantity many times that consumed in the operation.

Units of Fire

The stockage of ammunition supply points and depots on the basis of units of fire results in some items being stocked in excess quantities, while others may be inadequate.

To overcome the bad features of the existing system, field commanders and staff officers tried a number of expedients. These generally fell into two classes—either a revision of the concept and use of the term "unit of fire" to make it a flexible unit, or the adoption of a new system dealing directly in rounds of ammunition. The establishment of a flexible unit of fire overcame most of the disadvantages but had the bad feature of continuing the use of a term which had been misused and misunderstood by many people, and so tended to perpetuate the former abuses.

By a series of changes the First Army developed a system which

worked well and formed the basis for the system presently prescribed by the Department of the Army. Similar systems were developed independently by other commands. Thus we see that the present system is not just an academic dream but was tested in the heat of battle.

Terminology

An understanding of the terminology used in the new system will assist in understanding its operation. The term "unit of fire" has been abolished, and the credit system for the control of ammunition supply in the combat zone is no longer used. The principal terms now used are:

1. *Basic Load*.—The basic load is the amount of ammunition to be carried by a unit in its organic transportation. It is expressed in rounds by type or appropriate unit of measure for bulk allotment items, such as demolition explosive. It is a fixed amount of ammunition established by the Department of the Army concurrently with the publication of the table of organization and equipment for the unit.

2. *Ammunition Day of Supply*.—The ammunition day of supply consists of the estimated quantity of ammunition required per day to sustain operations in an active theater. It is based on all weapons authorized to be in the hands of troops in the theater, including weapons in inactive units. Because of this basis the ammunition day of supply figure is not appropriate for use in determining requirements for a tactical unit in the combat zone. The ammunition day of supply is announced by the Department of the Army and need not be the same for all theaters of operation.

3. *Required Supply Rate*.—The required supply rate is the amount of ammunition for each type weapon, expressed in rounds per weapon per day, or appropriate bulk measure, required to sustain operations of any designated force without restriction. This is not a fixed rate and is changed to conform to the progress of operations. It is computed on and applied to tactical weapons only (weapons in divisions and crew-served weapons of nondivisional tactical units; weapons in combat service support and service support units are excluded).

4. *Available Supply Rate*.—The available supply rate is the rate of consumption in rounds per weapon per day or appropriate bulk measure which can be sustained with available supplies as announced by each commander and applicable within his command. This rate is flexible and conforms to changing operational plans and changing tactical conditions.

When a new theater of operations is established, the Department of the Army will fix the ammunition day of supply rates to be used until such time as experience within the theater provides a firm basis for correction. Theater commanders will make continuous studies of ammunition consumption and recommend necessary changes in the ammunition day of supply rate for their theaters so that it will reflect the experience, type of operations, and plans of the theater concerned.

Ammunition Supply Rate

The Department of the Army prescribes the level of supply to be held in the theater in terms of the ammunition supply rate. In keeping with the over-all theater level of supply, the theater commander apportions the level of supply of ammunition to be stocked within the combat and communications zones. Ammunition in the hands of troops is not considered in the computation of the level of supply.

The theater commander will establish an ammunition credit system applicable to the theater and, based upon the estimated available supply rate, will periodically allocate ammunition credits to the army groups or armies upon recommendation of the army group commanders. The credit system is not authorized for use below army level.

Requirement Estimated

The required supply rate is determined by each commander from the division level through the army group. It is the commander's estimate of the ammunition required daily by his command for a particular period of time, normally seven to ten days, taking into consideration the nature of the combat anticipated. This requirement is furnished to the next higher commander, who uses it in determining his required supply rate. The army group —or army, if no army group exists— determines the amount of ammunition which will be available to it for the ensuing period.

The ammunition to be available is that within the army depots and supply points, plus the ammunition received from the communications zone.

Available Supply Rate

If a comparison of the ammunition to become available with the total required shows that there will be a shortage of any given type of ammunition, the army group establishes an available supply rate for that item for each major subordinate command. The available supply rates for subordinate commands need not be the same but will take into consideration the nature of combat each command may encounter.

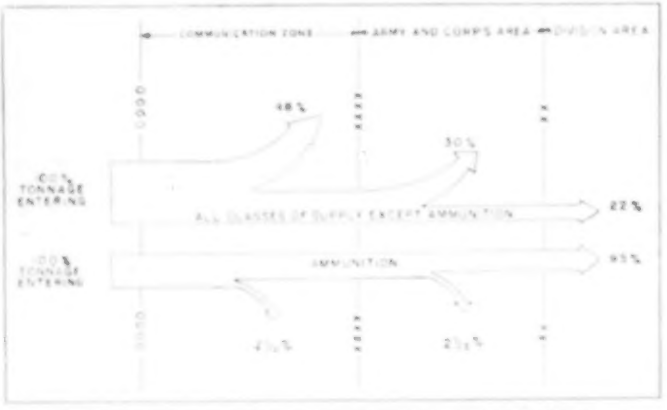


Fig. 1. Per cent consumption, by area, of supplies entering the theater.

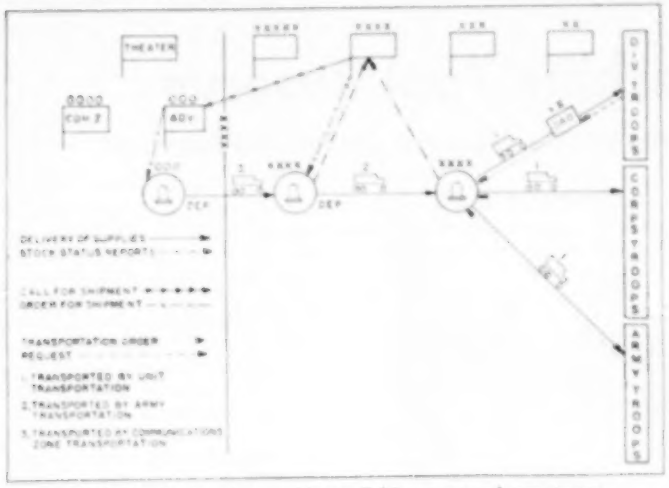


Fig. 2. Distribution of ammunition to division, corps, and army troops.

Each headquarters below the army group determines the available supply rates for its subordinate commands when it receives its available supply rates from the next higher headquarters. Thus the required supply rates are determined progressively upward from the using unit and the available supply rate is established progressively downward to the using unit.

In actual operation a commander would know from expenditure experience what required supply rate might be anticipated under various combat conditions. For training purposes, and as a guide in a new theater, typical required supply rates are shown in Field Manual 101-10 for different types of combat and for a protracted period. The values for a protracted period cover a weighted average of various types of combat.

Echeloned in Depth

Any ammunition supply system must be echeloned in depth in order to insure an adequate supply of ammunition to the combat troops. This is accomplished by providing a basic load in the hands of the using unit sufficient to take care of an average two days of hard fighting and the means for continually replacing this ammunition. For this system to guarantee proper ammunition supply it is first necessary to determine the proper basic load for the unit.

In doing this, consideration must be given to several factors, the most important of which are: the ability of the unit to carry the ammunition, its facilities for resupplying itself, and its position during combat relative to the location of the ammunition supply point.

Supply Points

Having provided an adequate basic load, it is next necessary to maintain ammunition supply points which can be reached easily by all units, so that resupply can be accomplished in an 8-hour turnaround time. The ammunition supply point will normally stock two or three days' supply, depending upon the nature of the tactical operations. One or more ammunition supply points will be established to support each corps—depending upon the terrain—but one ammunition supply point should not support elements of more than one corps.

The army Ordnance officer will order shipments from the army ammunition depot to maintain stock levels in the ammunition supply point based upon its expenditure report. To save rehandling, shipments are sometimes made direct from the communications-zone depot to the ammunition supply point.

The bulk of the ammunition authorized for stockage in the combat zone will be held in the army ammunition depot at a point where resupply may be made to the ammunition supply points in about twelve hours. This depot will normally stock about fifteen days' supply at the required or available supply rate.

These depots are resupplied by calling shipments forward from the communications zone against credits established for the army. As the troops move forward, the ammunition supply points and the army ammunition depots move forward to give support.

The Last Link

The communications-zone depots are the last link in the ammunition supply system in the theater. The number and location of these depends upon the size of the communications zone and the transportation network. If the communications zone is divided into sections, these depots will be under the communications-zone section in which they are located.

Each unit will replenish its basic load by drawing ammunition from the ammunition supply point designated to support it. The unit commander will accomplish his responsibility for procurement of the replenishment ammunition by sending trucks to the supporting ammunition supply point with a transportation order bearing the statement: "Required to replenish basic load (or required for immediate consumption). Expenditures are within authorized available supply rates."

Trucks of divisional units will stop at the division ammunition office (DAO) enroute to the ammunition supply point. The division ammunition officer will check the request for ammunition against the available supply rates and previous issues. He will approve the transportation order and advise the driver of any changes in locations of ammunition supply points.

The new system reduces the number of reports required from the using units. A report of ammunition on hand in units is no longer required except in the case of excess ammunition, since the basic load is established and must be continually replaced as expended.

The combat units are not required to submit expenditure reports because the ammunition is considered as expended when issued by the ammunition supply point.

Thus it can be seen that this system insures adequate ammunition supply to the using units with a minimum of administrative effort.

The Machine Tool Reserve

A Vital Necessity to the Modern Defense Program

by

Lieut. Col. D. E. Breakfield

The machine-tool industry should never be allowed, because of a lack of peacetime orders, to shrink below its capacity to recover quickly upon receipt of emergency military orders

FROM 1939 to 1945 the United States Government spent billions of dollars for basic machines. These machines—machine tools—were produced by the thousands, and were used to equip the greatly expanded wartime industrial programs of all the Allied Forces. The major demand for these machine tools came early in the war and placed a tremendous burden on the machine-tool industry. The probability of such a demand had been foreseen from the experiences during the First World War, although the magnitude of this future demand had not been fully appreciated.

Reserve Established

At the end of World War I a reserve of industrial equipment was established by the War and Navy Departments. This reserve equipment was placed in storage at various Government facilities throughout the country for use in future emergencies. Again, at the close of the European and Asiatic struggles, a policy for creating a similar equipment reserve was formulated. This time the factors to be considered were much more complicated.

Larger stocks of surplus equipment on hand, greater varieties of complex machine designs and operating features, and integrated combinations of mass-production equipment made necessary a variety of solutions for the reserve policy. It resulted in varied programs for (1) the retention of stand-by plant facilities, (2) reequipment of Government arsenals, and (3) the reserve storage at certain Government establishments of large quantities of equipment consisting mostly of machine tools.

Several Weaknesses

These programs have been found to have several weaknesses which, in general, were the result of an imperfect evaluation of past experiences when policy decisions for future actions were made. The experiences after the First World War were, in many cases, passed over too lightly when the present programs concerning industrial equipment were established.

Weaknesses of the First World War program including (1) lack of coordination between the services, (2) inadequate funds for the maintenance of equipment in reserve, and (3) improper safeguarding of this equipment while in storage, still have not been thoroughly eliminated from the programs now in force. In addition, a depreciation policy, which was lacking entirely in all previous Government equipment programs, is still not properly integrated into the current equipment-reserve policies.

The armed forces policies on machine equipment since the end of World War II have been definitely superior to those followed during the 'twenties and 'thirties. Positive steps have been taken to retool arsenals, retain stand-by manufacturing facilities, and establish a large machine-tool reserve. These programs have been coordinated by the national military establishment, and, by means of various inspections of equipment and reviews

ARMY ORDNANCE ARSENALS

	Arsenal No. 1		Arsenal No. 2		Arsenal No. 3		Arsenal No. 4	
Type Machine Tool	*Machines 20 years old or older*	*Total Machines*	*Machines 20 years old or older*	*Total Machines*	*Machines 20 years old or older*	*Total Machines*	*Machines 20 years old or older*	*Total Machines*
Lathes	88	150	437	455	254	291	174	174
Millers	311	416	307	334	83	99	164	173
Shapers Slotters Planers	17	24	154	161	128	143	100	102
Horizontal and Vertical Boring			111	119	80	100	23	30
Grinding			119	139	52	103	186	214
TOTAL	547	759	1237	1347	684	840	725	825
Percent	72	100	93	100	77	100	94	100

American Machinist, February 8, 1939, pp. 106-109.

Fig. 1. Machine tools 20 or more years old in service at Army arsenals in 1939.

or local storage facilities, a uniform policy-action has been maintained.

In many respects the present program has been well conceived and well supervised. But it is still in its infancy. None of the tools in storage are over ten years old. They are still modern tools.

What of the Future?

What is going to happen to these tools in the next ten years? Will the arsenals obtain machine replacements or will the over-all age of their equipment increase constantly as it did after the First World War? (The age of machine tools in the Arsenals in 1939 may be appreciated in reviewing the facts presented in Figure 1.) Will stand-by plants receive proper periodic inspections and adequate care, or will they become forgotten storage areas? Will the reserve machine tools be actively reviewed and positively controlled or will they be neglected except by those who would systematically rob them to nourish current underappropriated manufacturing operations?

The effect of governmental policies during the next ten years is of particular importance when the 112,000 tools in war reserve are considered. These tools have a value of many millions of dollars, they represent a great manufacturing potential, and they are insurance on M-Day against excessive delays in the manufacture of critical defense matériel.

Yet day by day they are decreasing in money value. They are losing their manufacturing potential by reason of the daily improvements in methods and techniques of manufacture. They are becoming less and less of an insurance on M-Day. Their existence may foster a false sense of security.

Reëvaluation

For these reasons the reserve program must be evaluated year by year, and this evaluation must be given wide publicity throughout the defense establishment.

Changes in the program must be considered at all times because the critical period for these tools has not yet been reached. What action should be taken when these tools have aged another five years—another ten years? Will the policies that are being followed now be satisfactory then? It is doubtful if they will. To follow the present policies without revision may (1) foster the same laxities that caused World War I equipment to be saved twenty years before it was released into an industrial world of more modern and efficient manufacturing devices; (2) place the same unnecessary burden on the machine-tool industry that was placed on it during the period of 1940-1942; and (3) pave the way for the wide split between industrial and military activities that has been characteristic of all peacetime periods. None of these results should be allowed either by design or through a lack of attention to the war reserve machine problem.

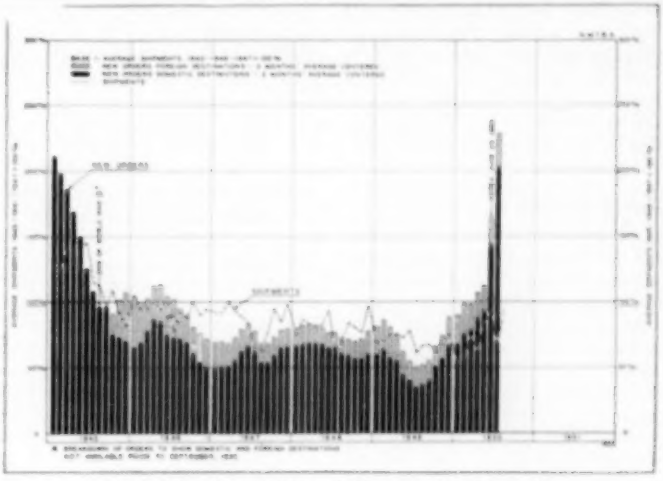


Fig. 2. Index of new orders and shipments of machine tools.

The reserve equipment program is critical to industry, to the military, and to the Nation. It must be constantly reviewed in order that positive controls be maintained over equipment in storage and in stand-by plants. All interested personnel should be kept alert to the necessity for a thorough and constant appraisal of (1) the condition of equipment in storage, (2) new equipment developments, (3) new manufacturing processes and the changing status of military products, (4) the necessary periodic justifications for reserve equipment expenditures, and (5) the effect of defense-policy decisions on the machine-tool industry.

Those persons who prepare and present to Congress the yearly requests for funds for the maintenance of this equipment must be capable of showing in dollars and cents the effect that variations in appropriations will cause. Both physical depreciation (due to handling and preparation for shipment, storage, and use) and functional depreciation (obsolescence and inadequacy resulting from developments in tools and processes of manufacture) should be carefully indicated in all budget presentations.

Periodic Inspection

Equipment in storage and in stand-by requires periodic inspection to assure that the conditions of storage are proper and that the means of preparation for storage are adequate. Many of the weaknesses in the First World War storage program stemmed from a lack of adequate and scheduled inspections. The present program may be criticized quite severely on this point. A survey in 1948 revealed that although Government equipment reserves were available to bridge, in part, the gap between early requirements and the attainment by the machine-tool industry of full wartime output, the poor condition of many of these tools has reduced the value of this resource.

Critical comments have been made

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to the effect that (1) overhauling and processing have not been satisfactory at all storage points and (2) a comprehensive inventory of reserve tools does not exist. It is noted, however, that the services are undertaking measures to improve inspection and processing methods.

Liaison Needed

All developments in tools, including jigs and fixtures, machine attachments and modifications should be made available to the armed forces. This requires close liaison between the armed forces and the machine-tool industry, and the armed forces and industry as a whole. In peacetime, Government operations, including technical planning, are inclined to fall behind the progress of industry because of a lack of funds for investigational work and the absence of a direct and energetic competitive incentive.

These factors can be overcome by the concerted action of the defense establishment and industry. The American Ordnance Association is actively maintaining this necessary liaison and has built up a spirit of teamwork through industrial and military committees. Military research, development, and manufacturing problems are carefully reviewed by industry. The importance of teamwork of this type cannot be too greatly stressed. Interchange of information by military and industrial groups should be sponsored by all national agencies.

The use of new tools on old products or in old manufacturing processes is usually a waste of time and effort. When a new product is developed or when a new process of manufacture is adopted, the news should be broadcast, and the military, in particular, should be informed. But it is not the job of industry to keep the military informed. The responsibility lies in the other direction.

Military technical groups should establish such positive relations with their counterpart in industry that the information flows naturally. Here again the American Ordnance Association has served as the necessary guiding hand. Active civilian committees are constantly reviewing with the military all phases of industrial product and process improvements and the results of military research and development.

The reserve tool program fits into this vital product-process developmental team because of its basic mission to stand ready to serve when needed. (Each tool in reserve is earmarked for a particular military program.) As new products and processes are developed, tools in reserve must be reviewed to determine those that may have to be discarded or transferred from one program to another. This review must be active; it must be closely linked with all phases of military and industrial manufacturing; it must be positively coördinated among all branches of the services.

Several policies could be placed in effect for the reserve equipment. This equipment could be frozen, without withdrawal or addition, until needed in an emergency. It could be made flexible by allowing its use on current operations if replacements by new equipment were made quickly. It could be used without replacement and thus be allowed to diminish gradually.

But, regardless of which policy is followed—and they range from one extreme to the other—there will be expenses day by day and year by year for this reserve program. In fact, it might be said that the effectiveness of the program is directly a function of the adequacy of funds for its maintenance. This point cannot be too strongly stressed.

The ability of the armed services to acquire sufficient funds for this program will determine whether the efforts expended in setting it up were of value. The adequacy of funds acquired will reflect the degree of justification presented in budget requests. These requests should be accompanied by the actual facts, which in turn should be supported by the best expert advice available on controversial subjects such as depreciation.

Room for Improvement

In the field of budget justification, all branches of the service can always show continued improvement. They must show continued improvement if the large Government investment in machine tools is to be protected through possible and probable future economy waves and recession periods.

The importance of the machine-tool industry should not be discounted in the considerations of war reserve program policies. This industry is such a necessary key to any equipment program that its welfare should be of as much concern in time of peace as it is in time of war. This fact is usually overlooked. It is customary for industry as a whole to accord machine-tool manufacturers little recognition when the need for increased production is not apparent. However, there is no reason why the military should adopt the same attitude.

When industry needs a piece of equipment it may lose a few dollars, or suffer a slight shift in its competitive position if the equipment is not available; but when the military needs equipment in time of emergency a lack of availability may mean the loss of lives and could possibly jeopardize the security of the Nation. No agency of the Government should gamble with a factor that might lead to an insecure national status. Policies on war reserve equipment could, if poorly advised, lead to such a gamble.

Unstable Indices

The operations of the machine-tool industry fluctuate widely. (See chart, Figure 2.) They are known to be the most unstable of all industrial indices. Therefore the Government should watch machine-tool orders very closely so as to determine when that industry's orders must be increased to assure proper machine-tool industrial organization and strength for future emergencies.

Educational orders for new type tools to be processed during peacetime and placed in war reserve could be used to fill the gap when industrial domestic and foreign orders are low. A schedule should be made for the acquisition of this type of equipment by considering the factors discussed in the preceding sections. In this way orders could be released to the machine-tool industry as required for immediate reserve needs.

The ability of the machine-tool industry to produce tools in quantity is a basic military necessity. This industry should never be allowed, because of a lack of peacetime orders, to shrink below its capacity to recover quickly upon the receipt of emergency military orders.

A well-planned, active, flexible, coördinated and foresighted war reserve machine-tool program is the answer.

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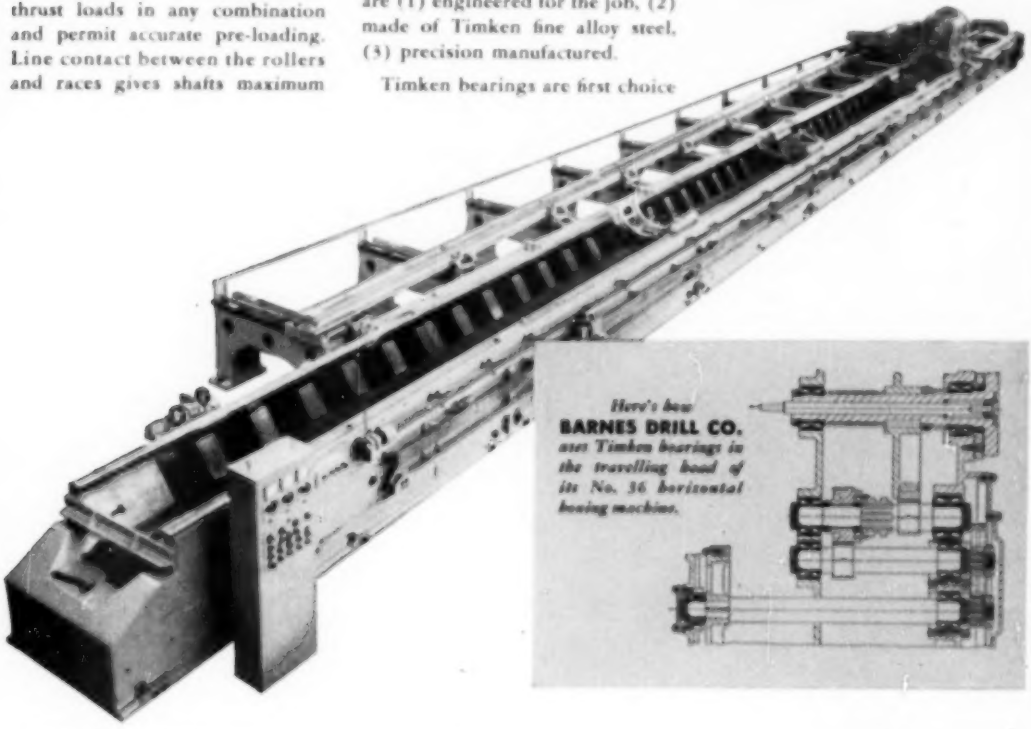

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